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DILLON RESOURCE AREA
RESOURCES INVENTORY:

WATER QUALITY SURVEY
Dillon West Unit

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INTRODUCTION

Watershed managers have traditionally been concerned with the quality of the waters that leave a watershed. As man modifies watersheds by various land use practices, disequilibrium in both the terrestrial and aquatic environments occurs. Problems result in controlling accelerated sediment and nutrient release from non-point sources within the basin. Stream water samples provide the investigator with insights into the general health of the patient. In an attempt to reduce watershed degradation, Congress recently mandated that local and regional agencies and authorities gather and assess environmental data for the lands and waters under their jurisdiction and authority. The Federal Water Pollution Control Act Amendments of 1972 (Public Law 92M-500) was promulgated to require: 1) the assessment of the sources and extent of non-point pollution, and 2) the development of methods and procedures for controlling non-point pollution resulting from agricultural and silvicultural activities (FWPCAA, 1972).

In April, 1976, personnel from the Montana Forest and Conservation Experiment Station began a resource inventory in southwest Montana for the Bureau of Land Management. This integrated resources inventory was designed by Bureau personnel to provide environmental data on watershed, wildlife, and range resources within portions of Beaverhead, Deer Lodge, Madison and Silver Bow counties near Dillon, Montana. More specifically, the National Resource Lands in the Rochester, Blacktail, Tendoy Mountains, Dillon West, and Centennial Planning Units were inventoried. The environmental data obtained is to be incorporated into the Bureau's Planning System and into the Mountain Foothills Range Environmental Impact Statement.

The water quality study portion of the above resource inventory project included the monitoring of 42 temporary stream sampling statons located in 17 drainage basins within the inventory area. Stream discharge, suspended sediment, hydrochemical values and bacteria levels were monitored at each sampling station for the 1977 and 1978 hydrologic years. In addition, the macrobenthic invertebrate communities at each station were sampled, the results of which are reported elsewhere. This volume presents the results of the water quality study for the Dillon West Planning Unit which includes Taylor, Dyce, Watson, Everson, Black Canyon, Nip and Tuck, Divide, Jeff Davis, and Shenon Creek sample basins.

METHOD

The basic experimental design of the water quality study, developed by Bureau personnel, includes the sampling scheme, field methods, and laboratory methods. Minor additions and modifications to the original design were subsequently incorporated into the study as field and laboratory conditions dictated or permitted. Specific comments on such alterations are included.

Inventory Design

The initial phase of the water quality study involved a stream reach inventory and channel stability evaluation of each designated stream reach. The method and procedures used during this evaluation are outlined in Pfankuch (1975). The stream reach ratings were completed during August and September, 1976.

The 42 stream sampling stations were established during September, 1976. The selection of each gaging station site was governed by criteria presented in Carter and Davidian (1968). Each stream sampling station included a staff gage, a crest-stage gage, and a max-min thermometer. A standard 3.3ft. staff gage was mounted to a fence post driven into the stream bed. A crest-stage gage was constructed of 3/4" diameter clear acrylic tubing, using modifications of the plans set forth in Buchanan and Somers (1968). This gage was afixed to the staff gage and fence post. The max-min thermometer was bolted within a piece of PVC pipe, laid on the stream bottom, and attached by a chain to a fence post.

In addition, a 15 unit precipitation gage network was established in the spring of 1977. A general purpose rain gage (forester type) was installed in a plywood frame at each designated sample location and placed in a clear, open site at a 12" height above ground level. This technique

conforms with that recommended by the World Meteorological Organization (World Meteorological Organization, 1969, as cited in Aldridge, 1976). Such a placement minimizes the error caused by wind eddying (Stringer, 1972, p. 29; Aldridge, 1976), and reduces the probability of disturbance or damage by livestock or vandals.

The stream and precipitation gage networks were monitored during the 1977 and 1978 hydrologic years. The basic design called for all stations to be visited on a prescribed schedule of weekly during peak runoff and monthly during low flow. The field seasons included: October - November, 1976; February and April - November, 1977; and March - September, 1978. The following water quality parameters were monitored as applicable. During each visit; stream discharge, suspended sediment, specific conductance, air temperature, water temperature, max-min water temperature, and precipitation were determined. Once a month, a water quality sample was taken for the following analyses: pH, alkalinity, calcium, magnesium, sodium, potassium, bicarbonate, sulfate, ammonia, nitrite-nitrate, and ortho-phosphate. A second stream water sample was obtained for bacterial analysis to determine levels of total and fecal coliform.

Macrobenthic invertebrate inventories were also conducted at each stream sampling station during May, July, and September of each hydrologic year. Four individual square foot samples for the smaller streams and 6 samples for the larger streams were obtained during 1977, while 2 and 4 samples respectively were obtained for the streams during 1978.

Field Methods

Discharge values were determined by standard techniques using procedures described in Buchanan and Somers (1968). Stream velocities

were taken with a Gurley Pygmy type model 625 current meter. Sediment samples were obtained with a US DH-48 sediment sampler in conformance with procedures in Guy and Norman (1970). Water temperatures were recorded from Taylor max-min thermometers. Precipitation was collected in standard 7" rain gage (forester type). Specific conductance was measured with a Delta Scientific Model 1914 conductivity meter. Hydrochemical samples were collected in acid washed polyethylene liter bottles, which were filled to exclude air, and stored in an ice chest during transport to the laboratory. Microbiological samples were collected in 250 ml sterilized glass bottles and also stored in the ice chest. The macrobenthic invertebrate samples were taken with a Kahlsico stream-bed fauna sampler.

Laboratory Methods

Immediately upon arrival at the Dillon laboratory, each sample bottle was opened and an unfiltered sample was analyzed for pH and alkalinity respectively. The values obtained closely represent the values at the time of collection in the field (Brown, Skougstad, and Fishman, 1970, p. 129), while minimizing the potential for instrument damage during transport or carriage over back country roads or trails. This method has been adopted by several USDA Forest Service personnel (Aubertin, 1974; Snyder, et al., 1975). PH was measured using an Orion pH probe and an Orion 407 ion analyser. Akalinity was then determined by potentiometric titration to a preselected end point with a standard acid, as outlined in Brown, et al., (1970).

A 100 milliliter aliquot for ammonia analysis was then acidified with 0.8 milliter concentrated sulfuric acid and refrigerated (American

Public Health Assoc., 1976, p.42). The remainder of each stream sample was subsequently filtered through a 0.45 μm (micrometer) membrane filter and frozen. Membrane filters were soaked for 24 hours before using to remove any traces of soluble phosphate or nitrate (A.P.H.A., 1976 p. 472). Ammonia samples were analyzed on an Orion Ammonia electrode, model 95-10 (Orion Research Incorp., 1974). This analysis was routinely preformed in the Dillon laboratory on the final day of field collection.

Upon return to the Missoula laboratory the frozen samples were defrosted for analysis in the following order; 1) filterable orthophosphate; 2) nitrite-nitrate; 3) sufate; and 4) common metals. Procedures followed were adapted from Standard Methods for the Examination of Water and Wastewaters (A.P.H.A, 1976), with the exception of nitrate which was taken from Methods for Chemical Analysis of Water and Wastes (Environmental Protection Agency, 1976). All colorimetric tests were preformed on a dual beam spectrophotometer (Beckmann ACTA model III). All glassware was acid washed.

The Asorbic Acid method, procedure 425F, (A.P.H.A., 1976) was used for dissolved orthophosphate. Results are expressed as PO_4-P. Nitrite and nitrate were determined collectively since nitrite usually occurs in insignificant amounts in uncontaminated surface waters. The sum of the two represents total oxidized nitrogen and is expresses as nitrite plus nitrate-nitrogen. The Cadmium Reduction Method (E.P.A., 1976) was selected because of its low detection limits (10 μg/l). Sulfate was measured using the turbidimetric method, procedure 427C, (A.P.H.A., 1976). During the 1977 field season measurements were made on a spectrophotometer, but during 1978 a nephelometer (Turner Designs, Inc., medel #40) was used. Both

methods are recommended in the procedure, although it was found the nephelometer increased the precision of the test. Sodium, potassium, magnesium and calcium were run in that order by atomic absorption spectroscopy (A.P.H.A., 1976) using a Varian Techtron AA-5 spectrophotometer. Lanthanum chloride solution was added to the samples for magnesium and calcium analyses to prevent anionic interferences (EPA, 1976). Total dissolved solids and bicarbonate concentrations were determined from specific conductance and alkalinity values using calculations presented in Brown, et al., (1970).

Nitrogen levels, ie. ammonia and nitrite-nitrate, are consistantly at the minimum detection limit of the analysis. Ammonia levels are particularly suspect owing to the limitations of the instrument and the technique for the analysis. In interpreting results of ammonia analysis; a presence or absence of detectable ammonia approach should be used. Thus high levels of ammonia indicate that a source of ammonia is present in addition to those which are naturally occurring. Such levels are usually transitory and may vary in order of magnitude. Nitrite - nitrate values are also near the minimum detection limit; however, the nature of this analysis yields more precise results. These values, as a whole, tend to be generally lower than those expected under the environmental conditions encountered. Low phosphate values are to be expected and were confirmed by this study. The method for phosphate analysis selected is the procedure generally used when working in this low range of values. The other ions, ie. sulfate and the common metals, tended to be present in sufficient quantities so that no problems were encountered owing to the sensitivity of the analyses.

Water samples for microbiological examination were analyzed within six hours of collection (Millipore, 1975a). Fecal coliform were cultured, identified, and enumerated throughout the study by the membrane filter method described by Millipore (1975b). Total coliform bacteria were cultured,

identified, and enumerated by the membrane filter method (Millipore, 1975a), but with the modifications outlined below.

Total coliform data for 1977 were determined by counting the number of wet colonies that exhibited a visible green metallic sheen, either to the naked eye or at 1.5x magnification. Millipore (1975a) recommends the use of a 10x magnification dissecting microscope and that the colonies be dry. Geldreich (1975), however, indicates that there is no significant advantage to drying the colonies before counting. Without the 10x magnification, however it is probable that colonies growing close together were mistaken as being one colony, and colonies having a weak metallic sheen were not counted at all. This procedure would result in data that would underestimate the number of total coliform colonies present.

A modification of the membrane filter method was adopted in 1978 to minimize the problem of underestimating the total coliform colonies. In the previous year, only the wet colonies exhibiting a distinct green metallic sheen were designated as coliform bacteria (Millipore, 1975a), while those wet colonies having a "non-sheen" red color darker than the medium-permeated background had not been counted. The degree of pigmentation and sheen development of coliform colonies grown on M-Endo medium, however, is variable according to both species and biotype. Furthermore, the identification criteria, i.e. colonies having a green iridescence or metallic sheen, is highly subjective and may vary from technician to technician. Thus, some authors admit that "questionable colonies" may occur which need more technical procedures for verification. One such procedure is to inoculate questionable colonies into a lactose broth, incubate at 35°C. for 48 hours, and determine whether gas and acid have been produced (Geldreich, 1975).

Using the above technique, an estimate of the fraction of questionable colonies was determined for which the lactose test was positive. After testing a series of 26 non-sheen, red colonies representing a variety of recognizable colonial morphotypes from several different stations, 69 percent were found to be lactose positive within 48 hours. Additionally, 16 percent of all dark red colonies found on 369 membrane filter samples exhibited a characteristic green sheen. It was thus estimated that approximately 75 percent of all red colonies darker than their membrane filter background conformed to either the green-sheen or lactose-test definitions of coliform bacteria. During the 1978 field season, all red colonies, sheen and non-sheen darker than their membrane filter background that were detected with the use of 10x magnification dissecting microscope were counted as total coliform. This procedure had the potential of overestimating the bacterial count by approximately 30 percent. It should be emphasized, however, that bacterial counts are not absolute values, but only estimates of magnitudes. Geldreich (1966, p.35) evaluated the total coliform bacteria for 40 samples using both the membrane filter method and the "most probable number" method. The ratio of their results varied from a minimum of 0.42 to a maximum of 2.52 respectively.

Tabulated total and fecal coliform data for this study are expressed as arithmetic means of either two or three replicated subsamples. Although the total coliform levels for the 1977 field season, i.e. May through November, 1977, are underestimated, the fecal coliform data for the two years are commensurate.

Analytical Methods

Stream discharge values were determined from field data with the use of a computer program based upon the procedure outlined in Buchanan and Somers (1969). These measured discharge values were then used to generate a staff-discharge rating curve for each station using a linear regression program. In several instances, two rating curves were produced. Instant and crest stage discharge values for the two water years were then estimated from the respective staff-discharge rating curves.

The annual hydrograph and sediment loading graphs were plotted with a computer using field data. Missing data points, i.e. winter months, were estimated using available stream flow, precipitation, and sediment concentration data. Estimates of annual water yield and annual sediment yield were generated by a modification of the computer program used to determine stream discharge. In a few instances, unusually high or questionable sediment concentration values, apparently caused by cattle present within the stream environs at the time of sampling or by sampling or analytical error, represented long sampling periods, i.e. 30 days. Where such conditions occurred, an estimated "corrected" level was substituted inorder to generate a more approximate determination of the annual sediment yield. The relationships between measured values of suspended sediment vs stream discharge and specific conductance vs stream discharge were determined by linear regression and plotted using the computer programs.

STUDY AREA

Beaverhead County, Montana

Beaverhead County is located in the southwestern corner of Montana immediately southwest of Butte. Almost the entire county lies above 5,000 feet and is encircled on the north, west, and south by the Continental Divide. The area is characterized by broad grassland and sagebursh covered valley bottoms and river terraces, while the flanks of the numerous mountain ranges grade into forest lands. The westernmost headwaters of the Missouri River drain the county to the northeast via the Big Hole and Beaverhead rivers. The forested mountain areas are generally administered by the Beaverhead National Forest of the USDA, Forest Service; the lower mountain slopes and terrace lands are managed by the Department of Interior's Bureau of Land Management; while the valley bottoms are mainly in private holdings. The land resources of the county are primarily allocated to the raising of livestock, although lumbering, mining, and recreation constitute secondary, but significant land uses.

The Bureau of Land Management's district office is located in the county seat of Dillon. The county contains a number of planning units administered by the Bureau. The Dillon West Planning Unit lies primarily west of Dillon and includes the Taylor, Dyce, Watson, Everson, Black Canyon, Nip and Tuck, Divide, Jeff Davis, and Shenon Creek sample basins.

Taylor Creek Basin

The Taylor Creek sample watershed (Figure 1) encompasses approximately 7,750 acres and includes the Lower Taylor, Middle Taylor, and Upper Taylor sampling stations. This narrow south facing basin ranges from approximately 6,100 feet to over 9,300 feet elevation. The upper and lower reaches contain moderate slopes, however the middle portion along the stream course is confined within a narrow gorge, where the flow regime is intermittent. Sedimentary and metasedimentary materials constitute the parent rock in the upper basin, while Tertiary and Quaternary sediments dominate the middle and lower reaches of the basin respectively. The watershed is characterized by mollisols, reflecting the predominantly sagebrush-grassland communities which cover most of the basin. Approximately 35 percent of the watershed is managed by the Beaverhead National Forest, 35 percent by the Bureau of Land Management, 25 percent is in private holdings, and less than 5 percent is State land. The basin is almost exclusively used for grazing purposes, although there was some mining activity in the area during the last century.

Lower Taylor Station

The Lower Taylor station No. 21 is located in the north central portion of Section 19, Township 7S, Range 11W (Figure 2), approximately 150 yards north of the highway. This location is found on the Grant, Montana 15 Series U.S. Geological Survey Topographic Quadrangle. The station is depicted as site No. 21 on aerial photo No. 2-111-7 of this resource inventory report, and is shown on stream station photos no. 21A and no. 21B. The station is located at 6,080 ft. elevation. The watershed above the station contains approximately 7,740 acres, has a local relief of 3,230 feet, and is oriented to the south. Approximately 10 percent of the watershed is forested.

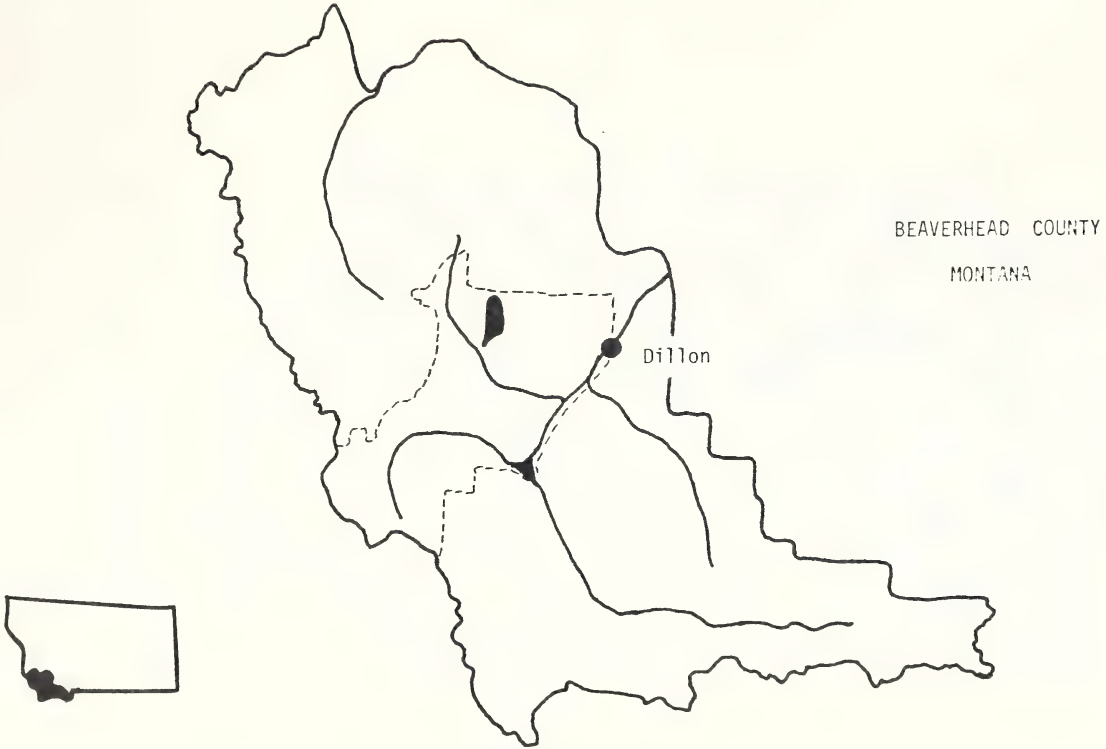

Figure 1. Location of Taylor Creek, Dillon West Planning Unit, Beaverhead County Montana.

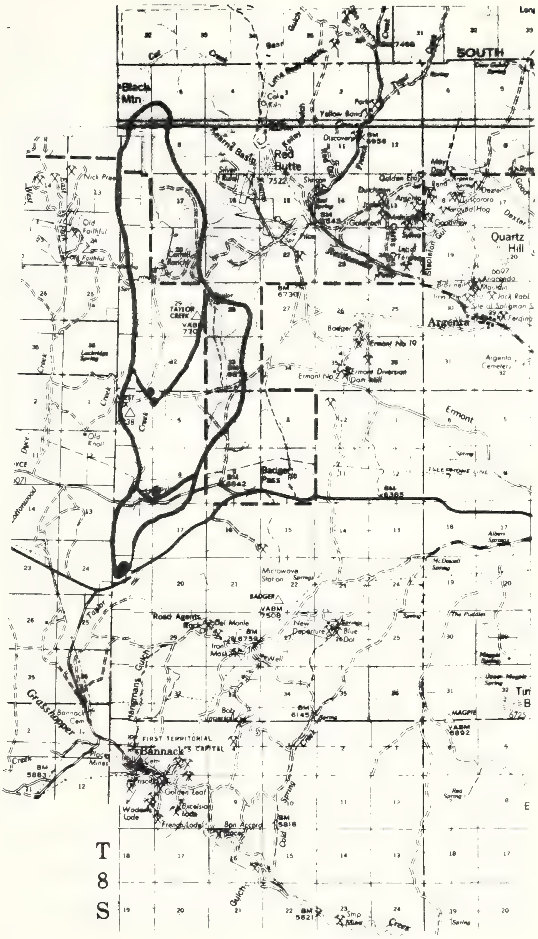

Figure 2. Location of Taylor Creek Sampling Stations.

Middle Taylor Station

The Middle Taylor station No. 22 is located in the southwest portion of Section 8, Township 7S, Range 11W (Figure 2), approximately 300 yards upstream from the road. The stream is intermittent at this site. This location is found on the Bannack, Montana 7.5 Series U.S. Geological Survey Topographic Quadrangle. The station is depicted as site No. 22 on aerial photo No. 2-111-7 of this resource inventory report, and is shown on stream station photos no. 22A and no. 22B. The station is located at 6,380 ft. elevation. The watershed above the station contains approximately 6,910 acres, has a local relief of 2,930 feet, and is oriented to the south. Approximately 15 percent of the watershed is forested.

Upper Taylor Station

The Upper Taylor station No. 23 is located in the northwest portion of Section 5, Township 7S, Range 11W (Figure 2), approximately 300 yards south of road and 350 yards downstream of fence. This location is found on the Ermont, Montana 7.5 Series U.S. Geological Survey Topographic Quadrangle. The station is depicted as site No. 23 on aerial photo No. 2-111-7 of this resource inventory report, and is shown on stream station photo no. 23A. The station is located at 6,610 ft. elevation. The watershed above the station contains approximately 4,420 acres, has a local relief of 2,700 feet, and is oriented to the south. Approximately 25 percent of the watershed is forested.

The Upper Taylor precipitation station No. 23G is located in the northeast portion of Section 6, Township 11W, Range 11W (Figure 2), on a terrace at a site approximately 25 yards upstream from the fence and 25 yards west of the creek. The station is depicted as site No. 23G on aerial photo 2-111-7 of this resource inventory report.

Dyce Creek Basin

The Dyce Creek sample basin (Figure 3) contains the Lower East Dyce, Upper East Dyce, Lower West Dyce and Upper West Dyce sampling stations. This study portion of Dyce Creek includes approximately 5,550 acres and drains the south slope of Baldy Mountain. These two relatively small and steep basins include a range in elevation from 6,550 feet to nearly 10,600 feet. The upper watershed is underlain by granitic parent materials, while the lower basin contains sedimentary and metasedimentary material, some of which are calcareous. The soils include entisols, inceptisols, and mollisols in the lower reaches. The upland portion is predominantly forested while the lower slopes and foothills are covered with sagebrush-grassland communities. Approximately 35 percent of the basin is administered by the Beaverhead National Forest, 55 percent by the Bureau of Land Management, and 10 percent is in private holdings. The basin is primarily used for livestock grazing, although there is modest recreational use of the area. Considerable mining activity occurred during the last century.

Lower East Dyce Station

The Lower East Dyce station No. 24 is located in the southeast portion of Section 26, Township 6S, Range 12W (Figure 4), approximately 300 yards above its confluence with West Dyce Creek. This location is found on the Polaris, Montana 15 Series U.S. Geological Survey Topographic Quadrangle. The station is depicted as site No. 24 on aerial photo No. 4-110-14 of this resource inventory report, and is shown on stream station photos no. 24(A) and no. 24(B). The station is located at 6,540 ft. elevation. The watershed above the station contains approximately 3,710 acres, has a local relief of 4,030 feet, and is oriented to the south.

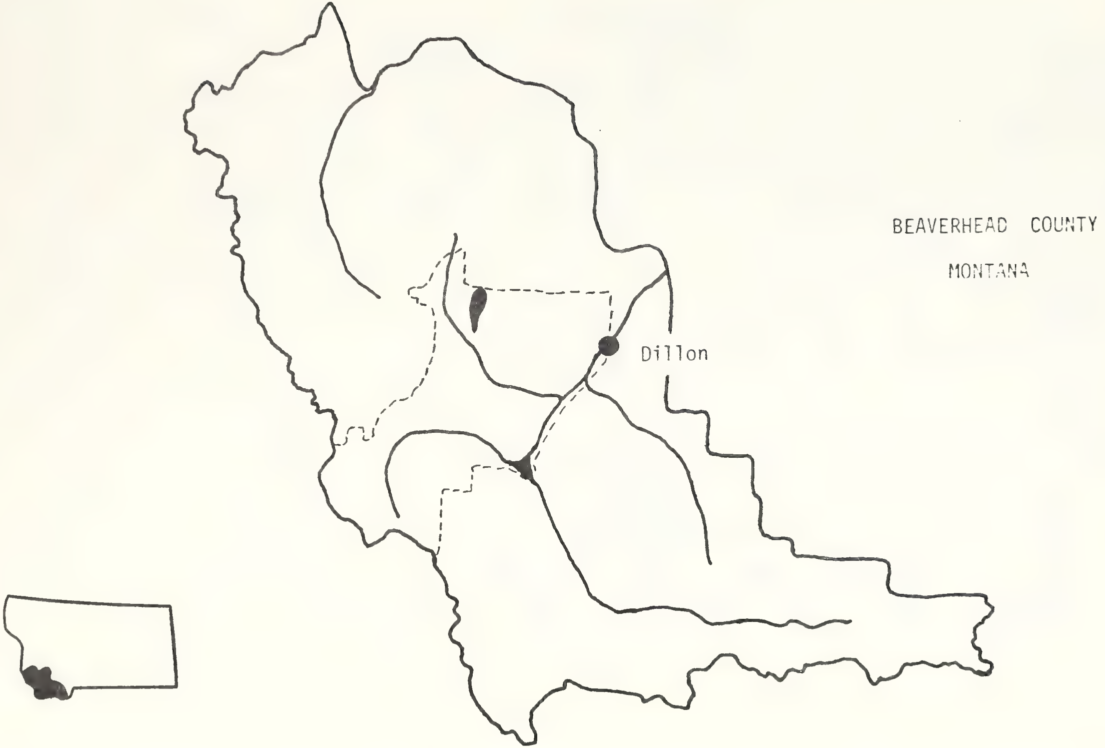

Figure 3 . Location of Dyce Creek, Dillon West Planning Unit, Beaverhead County, Montana.

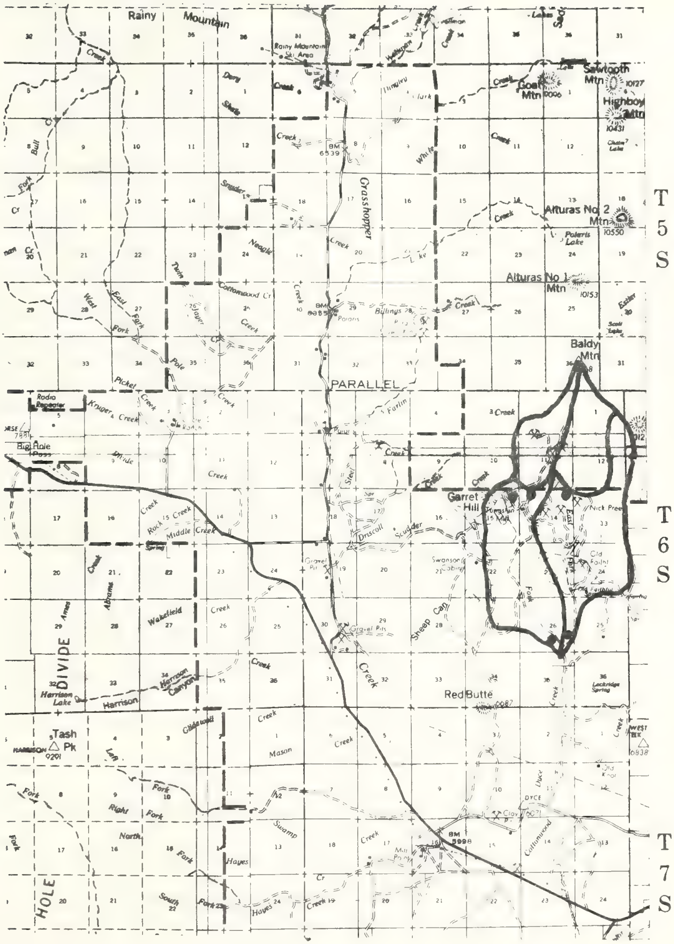

Figure 4. Location of Dyce Creek Sampling Stations.

Upper East Dyce Station

The Upper East Dyce station No. 25 is located in the northeast portion of Section 14, Township 6S, Range 12W (Figure 4), approximately 5 yards downstream of the Beaverhead National Forest boundary. This location is found on the Polaris, Montana 15 Series U.S. Geological Survey Topographic Quadrangle. The station is depicted as site No. 25 on aerial photo No. 3-109-74 of this resource inventory report, and is shown on stream station photo no. 25(A). The station is located at 7,380 ft. elevation. The watershed above the station contains approximately 990 acres, has a local relief of 3,190 feet, and is oriented to the south.

Lower West Dyce Station

The Lower West Dyce station No. 27 is located in the central portion of Section 26, Township 6S, Range 12W (Figure 4), approximately 1000 yards above the confluence with East Dyce Creek and 15 yards downstream from where the stream crosses under the road. The old station (1977 hydrologic year) was located approximately 50 yards upstream from the confluence with East Dyce Creek. This location is found on the Polaris, Montana 15 Series U.S. Geological Survey Topographic Quadrangle. The station is depicted as site No. 27 on aerial photo No. 4-110-14 of this resource inventory report, and is shown on stream station photos no. 27(A) and no. 27(B). The station is located at 6,560 ft. elevation. The watershed above the station contains approximately 2,050 acres, has a local relief of 2,880 feet, and is oriented to the south.

Upper West Dyce

The Upper West Dyce station No. 26 is located in the northwest portion of Section 14, Township 6S, Range 12W (Figure 4), approximately 5 yards downstream from Beaverhead National Forest boundary. This location is found on the Polaris, Montana 15 Series U.S. Geological Survey Topographic Quadrangle. The station is depicted as site No. 26 on aerial photo No. 3-109-76 of this resource inventory report, and is shown on stream station photos no. 26(A) and no. 26(B). The station is located at 7,520 ft. elevation. The watershed above the station contains approximately 450 acres, has a local relief of 1,920 feet, and is oriented to the south.

The Upper West Dyce precipitation station No. 26G is located in the northern portion on the west border of Section 14, Township 6S, Range 12W (Figure 4). The gage is located approximately 200 yards west and 40 yards south of the Forest Service fence on the west side of the road. The station is depicted as site No. 26G on aerial photograph 3-109-76 of this resource inventory report.

Watson Creek Basin

The Watson Creek sample basin (Figure 5) encompasses approximately 9,500 acres in two main tributary basins which contain the Lower Watson and Upper Watson sampling stations. Local relief for this primarily southeast facing basin ranges from approximately 6,250 feet to nearly 8,500 feet. Slopes are generally moderate and contain relatively open valleys. Although the upper reaches of the basin are composed of sedimentary and metasedimentary materials, the majority of the basin lies in Tertiary sediments. Most of the watershed soils are mollisols, reflecting the dominant sagebrush-grassland vegetation that covers this basin. Approximately 10 percent of the watershed is administered by the Beaverhead National Forest, almost 60 percent by the

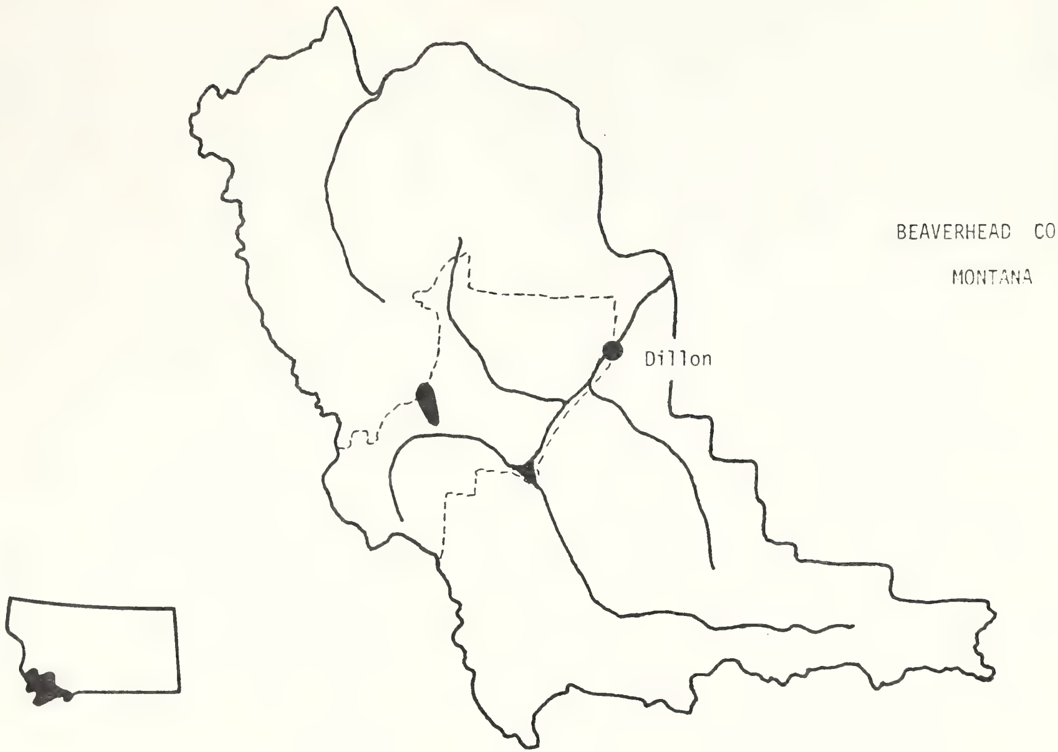

Figure 5 . Location of Watson Creek, Dillon West Planning Unit, Beaverhead County, Montana.

Bureau of Land Management, 25 percent is in State land, and less than 10 percent is in private holdings. This watershed is used primarily for livestock grazing.

Lower Watson Station

The Lower Watson station No. 28 is located on the southwest border of Section 11, Township 9S, Range 13W (Figure 6), approximately 20 yards above where the stream passes under the road. This location is found on the Grant, Montana 15 Series U.S. Geological Survey Topographic Quadrangle. The station is depicted as site No. 28 on aerial photo No. 5-115-91 of this resource inventory report, and is shown on stream station photos no. 28(A) and no. 28(B). The station is located at 6,230 ft. elevation. The watershed above the station contains approximately 6,490 acres, has a local relief of 1,770 feet, and is oriented to the south. Approximately 5 percent of the watershed is forested.

Upper Watson Station

The Upper Watson station No. 29 is located in the central portion of Section 10, Township 9S, Range 13W (Figure 6), approximately 20 yards upstream from where the fence crosses the stream. This location is found on the Grant, Montana 15 Series U.S. Geological Survey Topographic Quadrangle. The station is depicted as site No. 29 on aerial photo No. 5-115-91 of this resource inventory report, and is shown on stream station photos no. 29(A) and no. 29(B). The station is located at 6,320 ft. elevation. The watershed above the station contains approximately 3,010 acres, has a local relief of 2,160 feet, and is oriented to the south-southeast. Approximately 5 percent of the watershed is forested.

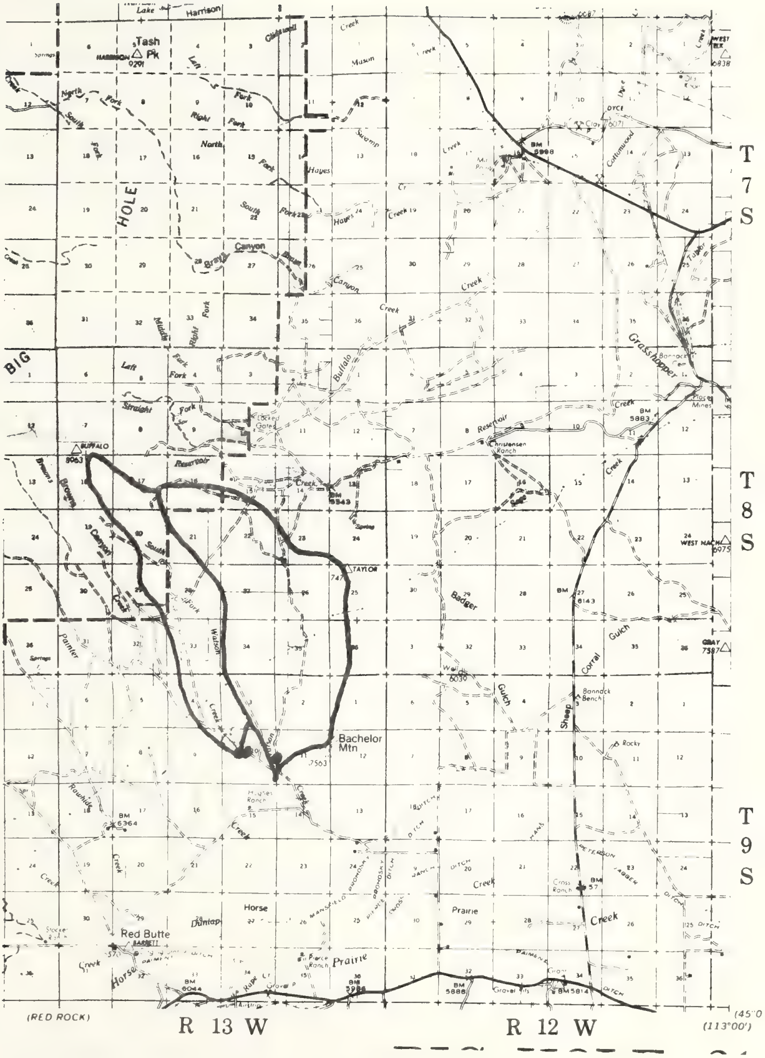

Figure 6. Location of the Watson Creek Sampling Stations.

The Upper Watson precipitation station No. 29G is located in the central portion of Section 10, Twonship 9S, Range 13W, (Figure 6). The gauge is approximately 15 yards northeast of the stream station at the bottom of the terrace between the road and station. The station is depicted as site No. 29G on aerial photograph 5-115-91 of this resource inventory report.

Everson Creek Basin

The Everson Creek sample watershed (Figure 7) encompasses a total of 4,500 acres within two tributary basins, which include the Lower North Everson, Upper North Everson, and South Everson sampling stations. These relatively steep northeast facing mountainous watersheds range in elevation from approximately 6,700 feet to almost 9,100 feet. The upper reaches of the watershed is composed of sedimentary and metasedimentary materials, while the lower reaches are of Tertiary volcanics and Tertiary sediments. Soils in these steep upper tributary basins are entisols and inceptisols, while the lower reaches are predominantly mollisols. The upper watershed and lower northern exposures are forested, the remainder of the area is covered by sagebrush-grassland communities. The Beaverhead National Forest administers approximately 35 percent of the watershed, the Bureau of Land Management controls the remaining 65 percent. The basin is predominantly used for livestock grazing.

Lower North Everson Station

The Lower North Everson station No. 30 is located in the east central portion of Section 5, Township 11S, Range 14W (Figure 8), approximately 150 yards upstream from where the creek passes under the road. This location is found on the Everson Creek, Montana 7.5 Series U.S. Geological Survey Topographic Quadrangle. The station is depicted as site No. 30 on aerial photo No. 5-118-107 of this resource inventory report, and is shown on stream

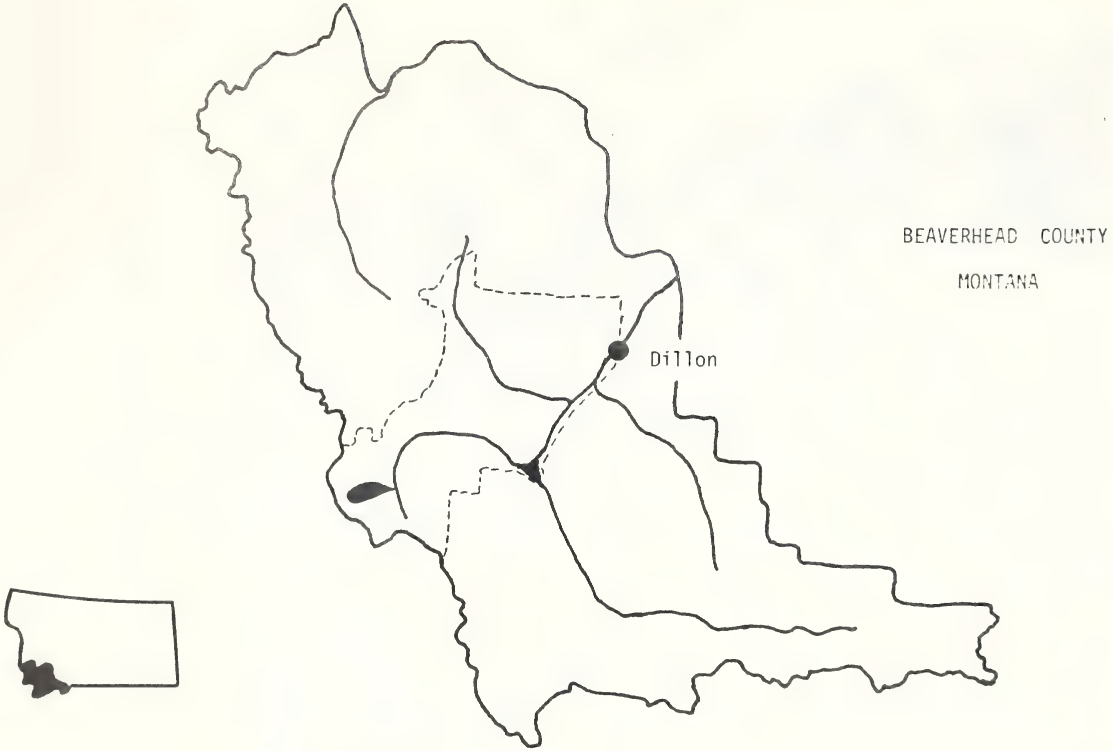

Figure 7. Location of Everson Creek,Dillon West Planning Unit, Beaverhead County, Montana.

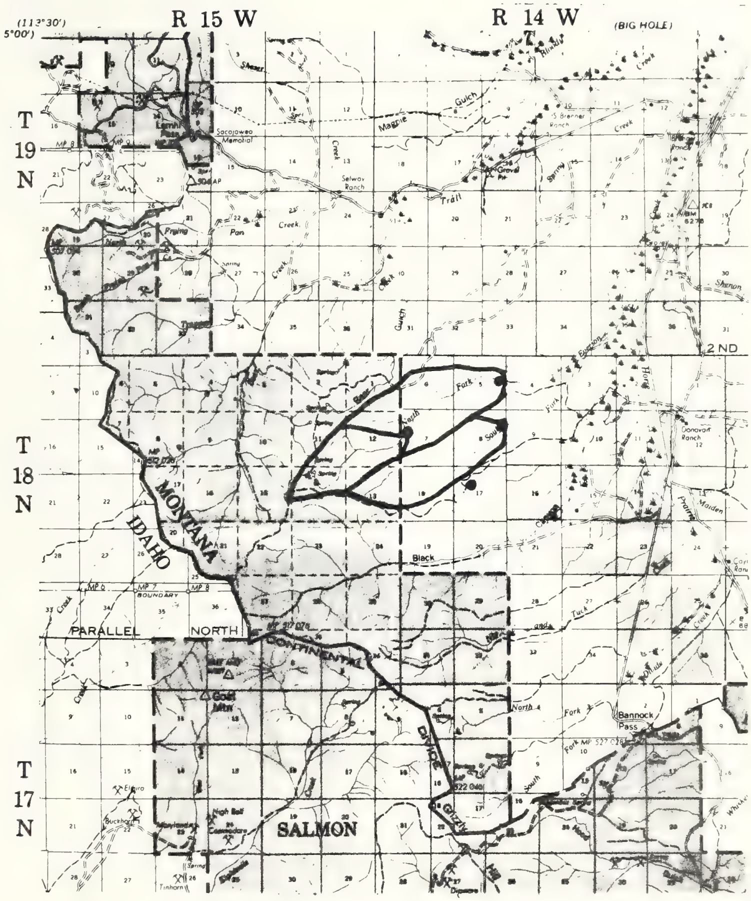

Figure 8. Location of Everson Creek Sampling Stations.

station photos no. 30(A) and no. 30(B). The station is located at 6,720 ft. elevation. The watershed above the station contains approximately 2,430 acres, has a local relief of 2,340 feet, and is oriented to the east-northeast. Approximately 50 percent of the watershed is forested.

Upper North Everson

The Upper North Everson station No. 31 is located in the west central portion of Section 7, Township 11S, Range 14W (Figure 8), approximately 200 yards below the Beaverhead National Forest boundary. This location is found on the Everson Creek, Montana 7.5 Series U.S. Geological Topographic Quadrangle. The station is depicted as site No. 31 on aerial photo No. 9-119-54 of this resource inventory report, and is shown on stream station photos no. 31(A) and no. 31(B). The station is located at 7,480 ft. elevation. The watershed above the station contains approximately 1,250 acres, has a local relief of 1,580 feet, and is oriented to the east-northeast. Approximately 80 percent of the watershed is forested.

South Everson Station

The South Everson station No. 32 is located in the northeast portion of Section 8, Township 11S, Range 14W (Figure 8), approximately 5 yards downstream from the road crossing. This location is found on the Everson Creek, Montana 7.5 Series U.S. Geological Survey Topographic Quadrangle. The station is depicted as site No. 32 on aerial photo No. 9-119-56 of this resource inventory report, and is shown on stream station photo no. 32(A). The station is located at 6,820 ft. elevation. The watershed above the station contains approximately 2,050 acres, has a local relief of 1,830 feet, and is oriented to the east-northeast. Approximately 60 percent of the watershed is forested.

The South Everson precipitation station No. 32G is located in the central portion of Section 17, Township 11S, Range 14W, (Figure 8). The gauge is located on the ridge line approximately 50 yards below the point where the road, coming down the ridge crest, takes a sharp 90° turn downslope into the South Everson drainage. The station is depicted as site No. 32G on aerial photo No. 9-119-56 of this resource inventory report.

Black Canyon Creek Basin

The Black Canyon Creek sample basin (Figure 9) encomposses approximately 7,300 acres, and contains the Lower Black Canyon and Upper Black Canyon sampling stations. This east-northeast facing mountainous watershed ranges in elevation from approximately 6,900 feet to 9,300 feet. The majority of the basin contains moderate to steep slopes, although the lower valley and flood plain become quite broad. The upper basin along the Continental Divide is composed of sedimentary and metasedimentary materials, while Tertiary volcanics and Tertiary sediments comprise the lower basin. Entisols and inceptisols predominate in the forested upper basin, while mollisols occur on the lower slopes and terraces of the sagebrush-grassland areas of the lower valley . The Beaverhead National Forest manages over 65 percent of the watershed, the Bureau of Land Management administers 30 percent, and less than 5 percent is State land. Livestock grazing is the major land use, although some recreational activity occurs within the basin.

Lower Black Canyon Station

The Lower Black Canyon station No. 34 is located in the central portion of Section 21, Township 11S, Range 14W (Figure 10), approximately 100 yards downstream from a point where an unnamed tributary basin joins the valley from the northwest. This location is found on the Bannock Pass, Montana 7.5

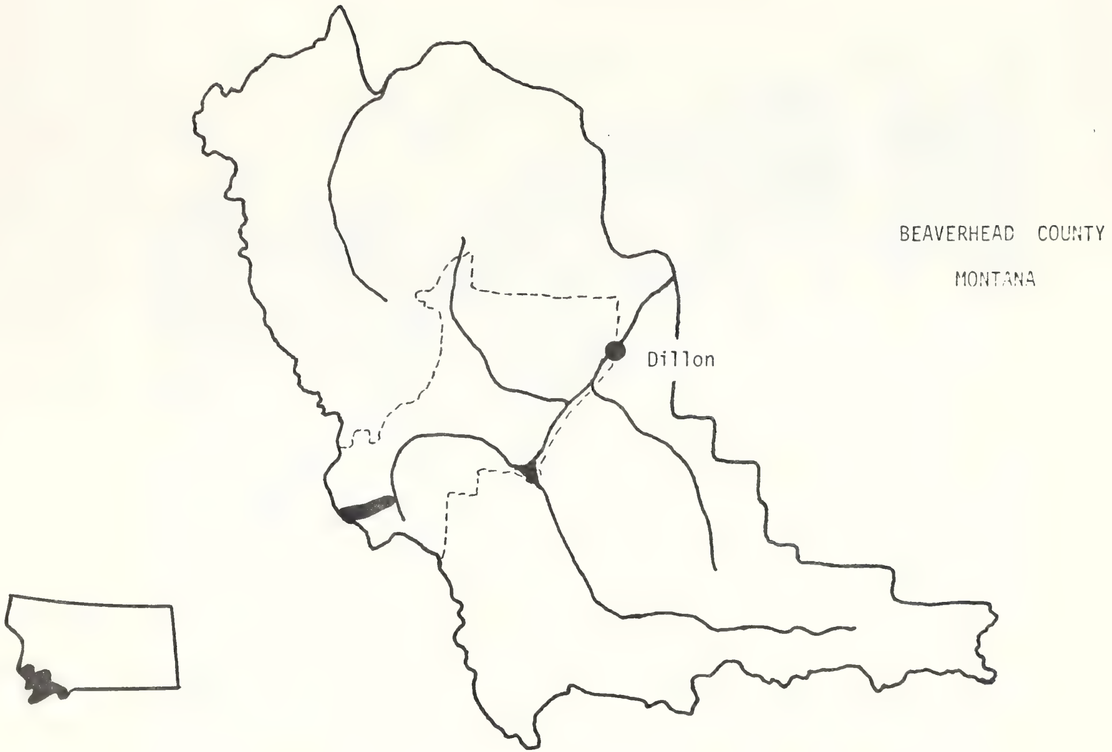

Figure 9. Location of Black Canyon Creek, Dillon West Planning Unit, Beaverhead County, Montana.

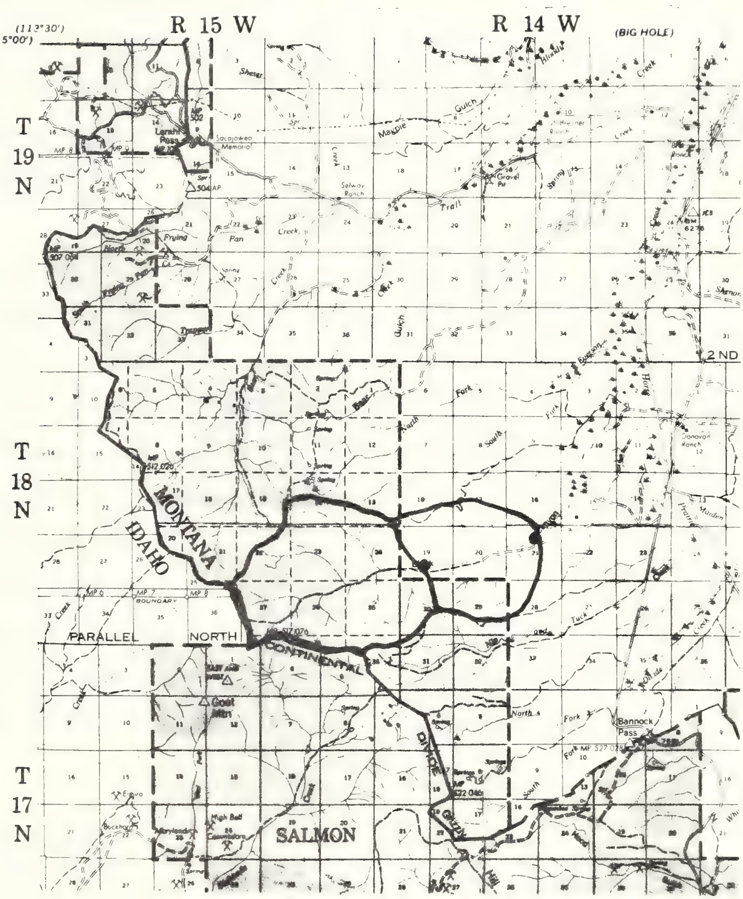

Figure 10. Location of Black Canyon Creek Sampling Stations.

Series U.S. Geological Survey Topographic Quadrangle. The station is depicted as site No. 34 on aerial photo No. 9-119-56 of this resource inventory report, and is shown on stream station photos no. 34(A) and no. 34(B). The station is located at 6,880 ft. elevation. The watershed above the station contains approximately 7,330 acres, has a local relief of 2,420 feet, and is oriented to the east-northeast. Approximately 55 percent of the watershed is forested.

Upper Black Canyon Station

The Upper Black Canyon station No. 33 is located in the southcentral portion of Section 19, Township 11S, Range 14W (Figure 10), approximately 400 yards downstream of Beaverhead National Forest boundary. This location is found on the Bannock Pass, Montana 7.5 Series U.S. Geological Survey Topographic Quadrangle. The station is depicted as site No. 33 on aerial photo No. 9-119-56 of this resource inventory report, and is shown on stream station photos no. 33(A) and no. 33(B). The station is located at 7,140 ft. elevation. The watershed above the station contains approximately 4,800 acres, has a local relief of 2,160 feet, and is oriented to the east-northeast. Approximately 70 percent of the watershed is forested.

Nip and Tuck Creek Basin

The Nip and Tuck Creek sample basin (Figure 11) includes approximately 4,000 acres and contains the Lower and Upper Nip and Tuck sampling stations. This primarily east-northeast oriented mountainous watershed ranges in elevation from nearly 6,950 feet to over 9,100 feet. The steep upper basin is composed of sedimentary and metasedimentary parent materials while the steep, but more open lower basin includes Tertiary sediments. Entisols and inceptisols

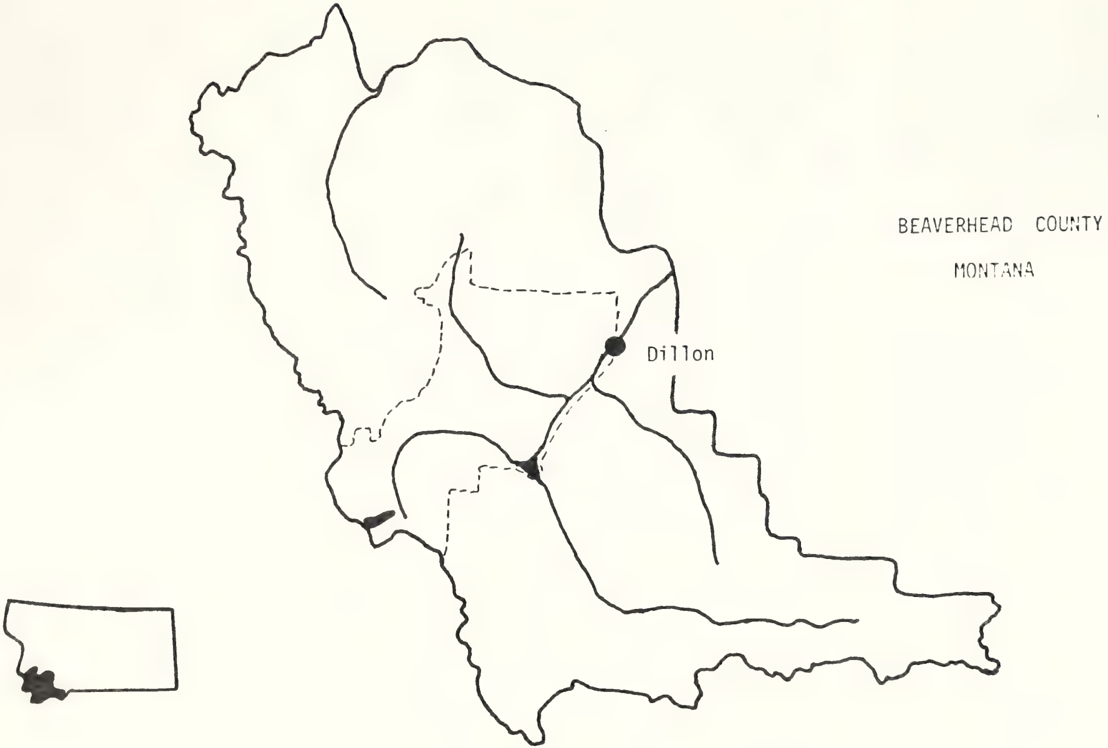

Figure 11. Location of Nip and Tuck Creek, Dillon West Planning Unit, Beaverhead County, Montana.

dominate the steeper uplands, and mollisols are found in the lower basin. Forests predominate on the northern exposures, sagebrush-grassland communities cover the remainder of the area. Almost 60 percent of the watershed is administered by the Beaverhead National Forest, 25 percent is in private holdings, and the Bureau of Land Management holds the remaining 15 percent. Livestock grazing is the major land use in the watershed.

Lower Nip and Tuck Station

The Lower Nip and Tuck station No. 36 is located on the west central portion of Section 26, Township 11S, Range 14W (Figure 12), approximately 20 yards below the fence at the section line. This location is found on the Bannock Pass, Montana 7.5 Series U.S. Geological Survey Topographic Quadrangle. The station is depicted as site No. 36 on aerial photo No. 5-120-93 of this resource inventory report, and is shown on stream station photos no. 36(A) and no. 36(B). The station is located at 6,940 ft. elevation. The watershed above the station contains approximately 4,030 acres, has a local relief of 2,170 feet, and is oriented to the east-northeast. Approximately 40 percent of the watershed is forested.

Upper Nip and Tuck Station

The Upper Nip and Tuck station No. 35 is located in the northwest portion of Section 33, Township 11S, Range 14W (Figure 12), approximately 200 yards downstream from the Beaverhead National Forest boundary. This location is found on the Bannock Pass, Montana 7.5 Series U.S. Geological Survey Topographic Quadrangle. The station is depicted as site No. 35 on aerial photo No. 8-120-93 of this resource inventory report, and is shown on stream station photo no. 35(A). The station is located at 7,380 ft. elevation. The watershed above the station contains approximately 2,020 acres, has a local relief of 1,730 feet, and is oriented to the east-northeast.

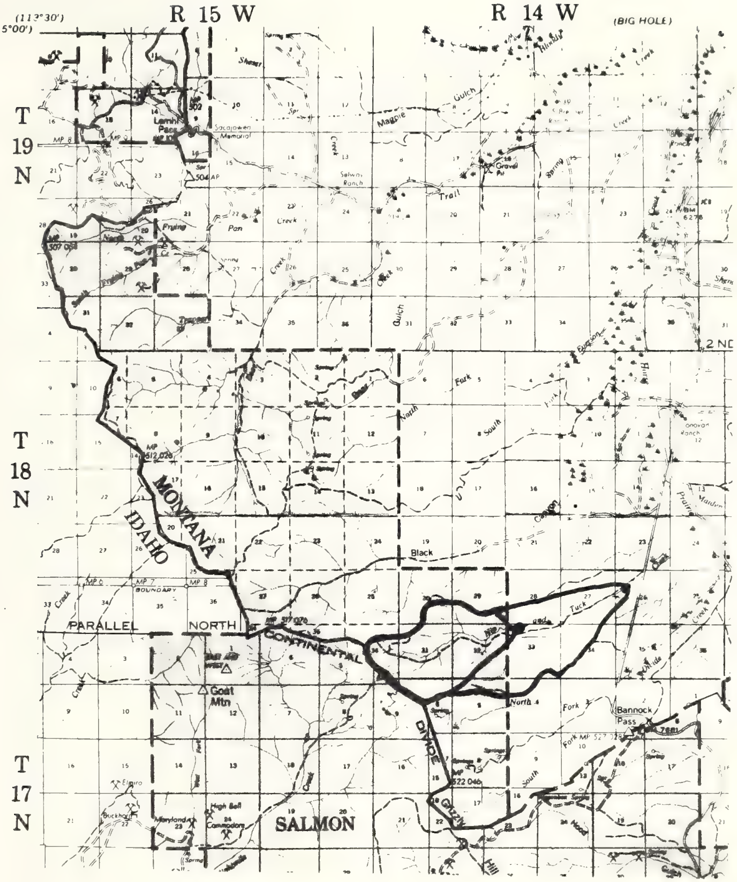

Figure 12. Location of Nip and Tuck Creek Sampling Stations.

Approximately 60 percent of the watershed is forested.

Divide Creek Basin

The Divide Creek sample watershed (Figure 13) includes an area of approximately 3,600 acres in two tributary basins that contain the North Divide and the South Divide sampling stations. This east-northeast oriented watershed abuts the Continental Divide at Bannock Pass. Local relief in the basin ranges from approximately 7,450 feet to almost 9,300 feet elevation. The upper portions of the basin are underlain by sedimentary and metasedimentary materials, while the lower basin is composed of Tertiary sediments. Forests cover almost 70 percent of the area, the remainder is in sagebrush and grassland communities on southerly exposures and at lower elevations. Entisols and inceptisols dominate the upper mountainous areas and mollisols occur in the lower basin. The Beaverhead National Forest administers approximately 45 percent of the basin, the Bureau of Land Management another 45 percent, 10 percent is in private holdings, and less than 5 percent is State land. The area traditionally has been used for livestock grazing, however a portion of the basin is presently being logged.

North Divide Station

The North Divide station No. 37 is located in the central portion of Section 3, Township 12S, Range 13W (Figure 14), approximately 10 yards downstream from the fence line crossing the creek. This location is found on the Bannock Pass, Montana 7.5 Series U.S. Geological Survey Topographic Quadrangle. The station is depicted as site No. 37 on aerial photo No. 8-120-93 of this resource inventory report, and is shown on stream station photo no. 37(A). The station is located at 7,440 ft. elevation. The watershed above the station contains approximately 1600 acres, has a local relief

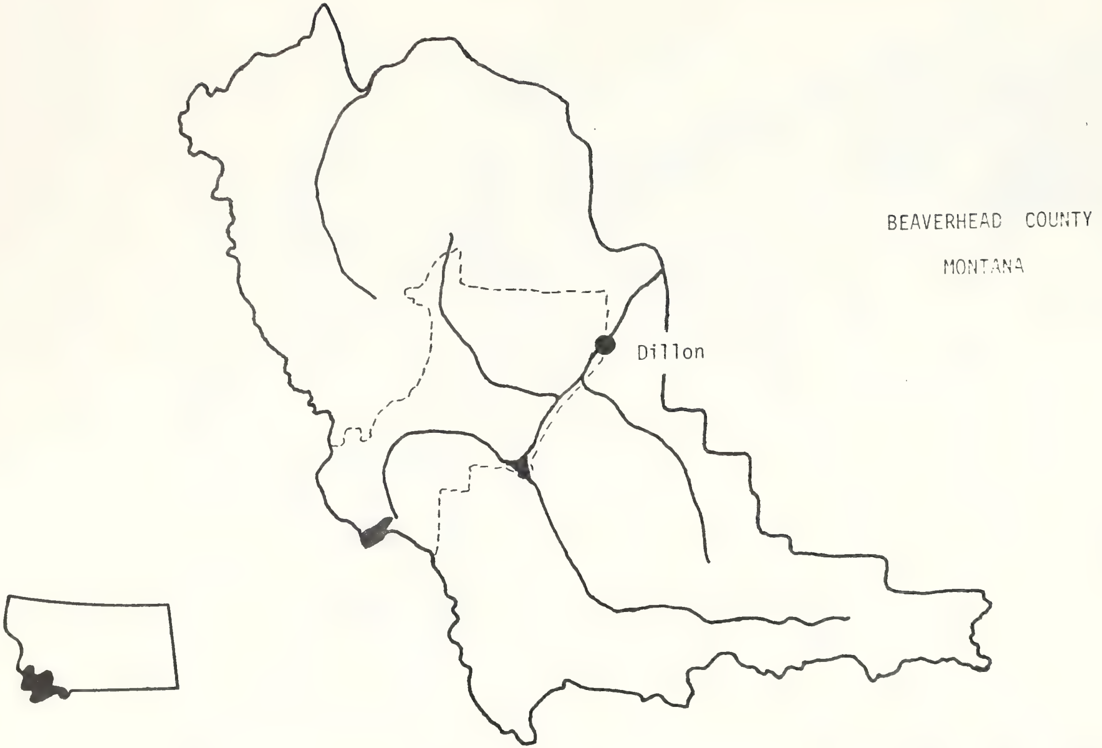

Figure 13. Location of Divide Creek, Dillon West Planning Unit, Beaverhead County, Montana.

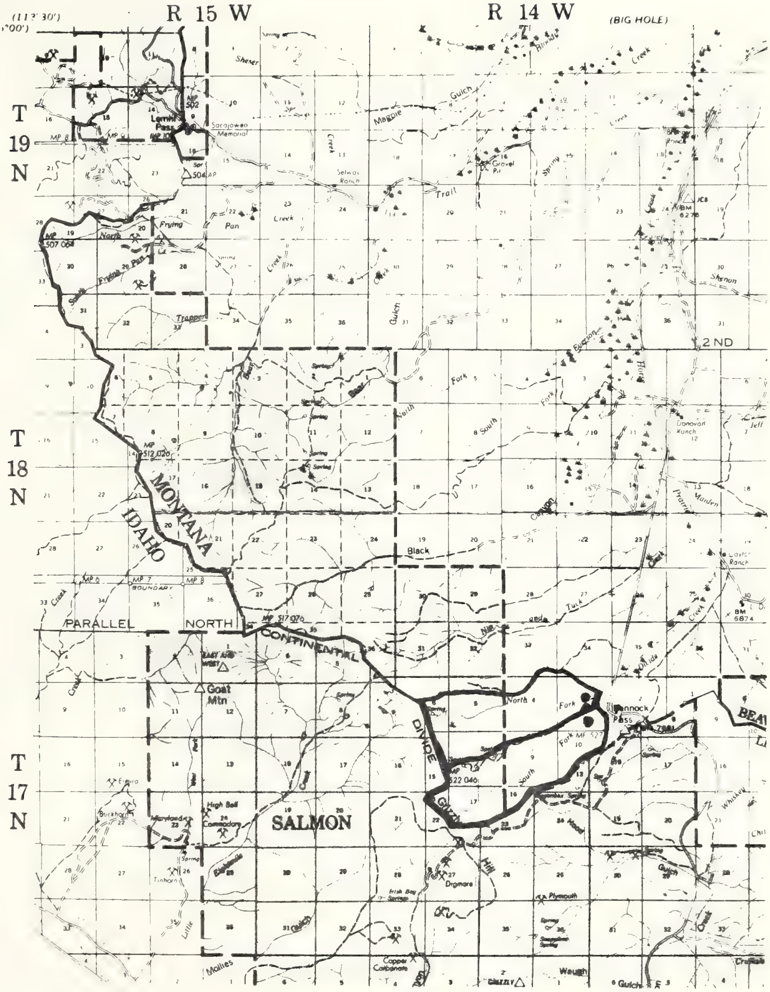

Figure 14. Location of the Divide Creek Sampling Stations.

of 1,560 feet, and is oriented to the east. Approximately 55 percent of the watershed is forested.

The North Divide precipitation station No. 37G is located in the central portion of Section 3, Township 12S, Range 14W (Figure 14). The gauge is approximately 200 yards uphill in a southerly direction from the stream gauging station and 100 yards east of the fence line. The station is depicted as site No. 37G on aerial photograph no. 8-120-93 of this resource inventory report.

South Divide Station

The South Divide station No. 38 is located in the south central portion of Section 3, Township 12S, Range 14W (Figure 14), approximately 300 yards upstream from the Bannock Pass road. This location is found on the Bannock Pass, Montana 7.5 Series U.S. Geological Survey Topographic Quadrangle. The station is depicted as site No. 38 on aerial photo No. 8-120-93 of this resource inventory report, and is shown on stream station photos no. 38(A) and no. 38(B). The station is located at 7,460 ft. elevation. The watershed above the station contains approximately 1,980 acres, has a local relief of 1,820 feet, and is oriented to the east-northeast. Approximately 80 percent of the watershed is forested.

Jeff Davis Creek Basin

The Jeff Davis Creek sample basin (Figure 15) includes approximately 8,000 acres and contains the Lower Jeff Davis and the Upper Jeff Davis sampling stations. This west-northwest facing watershed ranges in elevation from 6,600 feet to over 9,900 feet. The upper portion of the watershed is steep and mountainous, while the lower reaches include moderately sloping

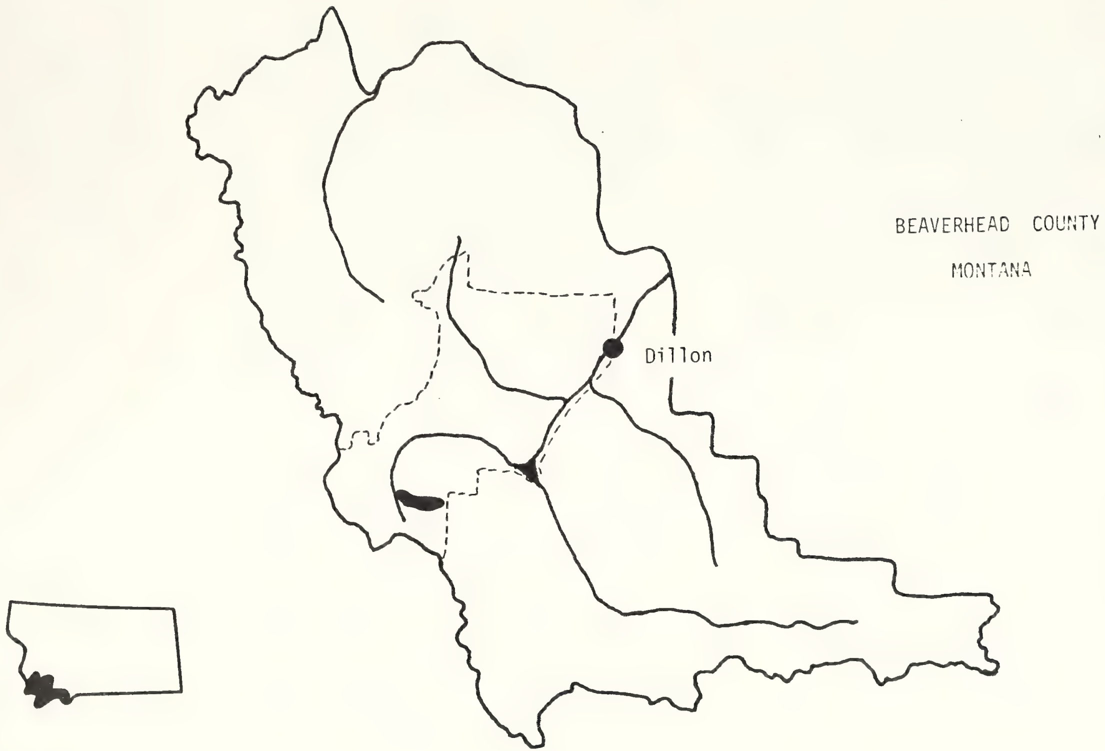

Figure 15. Location of Jeff Davis Creek, Dillon West Planning Unit, Beaverhead County Montana.

ridges enclosing a relatively wide valley. The headwater region is underlain by granitic parent materials, while the middle and lower reaches are composed of Tertiary volcanics and Tertiary sediments. Gold mine tailings cover much of the lower valley bottom. The soils in the mountainous headwaters are entisols, inceptisols, and associated talus deposits. Mollisols predominate in the lower basin on the sagebrush-grassland slopes and terraces. Approximately 50 percent of the basin is managed by the Beaverhead National Forest, 40 percent by the Bureau of Land Management, and 10 percent is in private holdings. Historically the basin was an important gold mining area, but current use is limited to livestock grazing.

Lower Jeff Davis Station

The Lower Jeff Davis station No. 40 is located in the northwest portion of Section 12, Township 11S, Range 13W (Figure 16), approximately 5 yards downstream of the Donovan Ranch driveway access road. This location is found on the Everson Creek, Montana 7.5 Series U.S. Geological Survey Topographic Quadrangle. The station is depicted as site No. 40 on aerial photo no. 40(A). The station is located at 6,590 ft. elevation. The watershed above the station contains approximately 8,000 acres, has a local relief of 3,360 feet, and is oriented to the west-northwest. Approximately 20 percent of the watershed is forested.

Upper Jeff Davis Station

The Upper Jeff Davis station No. 39 is located in the northwest portion of Section 16, Township 11S, Range 13W (Figure 16), approximately 15 yards upstream from section fencline. This location is found on the Jeff Davis Peak, Montana 7.5 Series U.S. Geological Survey Topographic Quadrangle. The

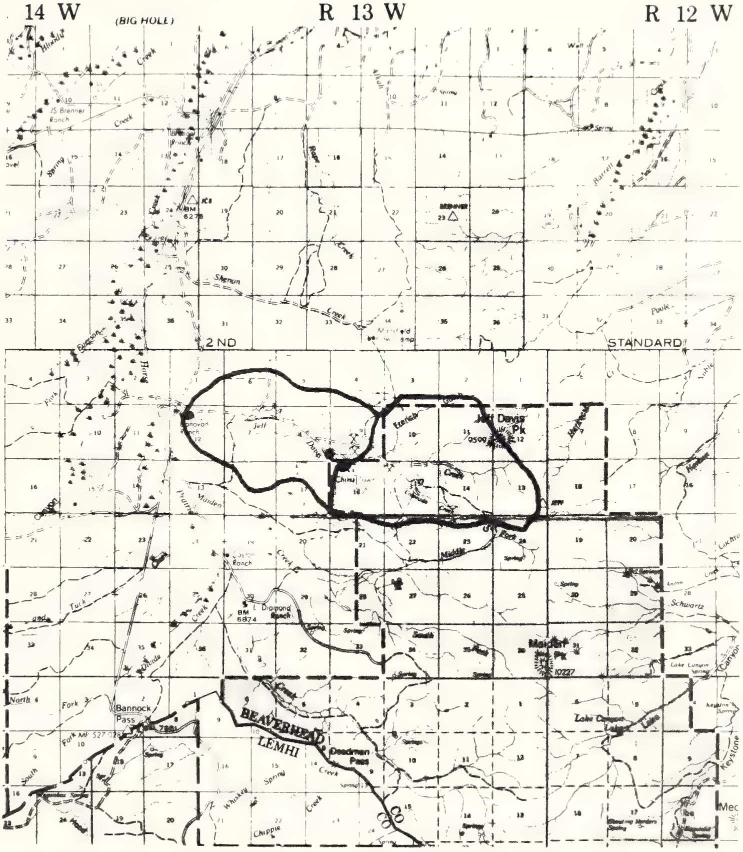

Figure 16. Location of the Jeff Davis Creek Sampling Stations.

station is depicted as site No. 39 on aerial photo No. 9-119-58 of this resource inventory report, and is shown on stream station photos no. 39(A) and no. 39(B). The station is located at 6,980 ft. elevation. The watershed above the station contains approximately 4,380 acres, has a local relief of 2,970 feet, and is oriented to the west-northwest. Approximately 40 percent of the watershed is forested.

The Upper Jeff Davis precipitation station No. 39G is located in the southeast portion of Section 8, Township 11S, Range 13W (Figure 16). The gauge is approximately 100 yards downstream from the section fence line and in the old tailings on the north side of the stream. The station is depicted as site No. 39G on aerial photograph 9-119-58 of this resource inventory report.

Shenon Creek Basin

The Shenon Creek sample watershed (Figure 17) encompasses approximately 5,100 acres and includes the Lower Shenon and Upper Shenon stations. This predominantly west-northwest facing watershed ranges in elevation from 6,400 feet to over 9,400 feet. The mountainous headwater region is composed of granitic parent materials, while the middle and lower portions of the basin are Tertiary volcanics and Tertiary sediments. The soils of the headwater region are predominantly entisols and inceptisols, while mollisols occur in the lower basin. Portions of the upper basin are partially forested, the remainder is covered by sagebrush-grassland communities. Approximately 60 percent of the basin is administered by the Bureau of Land Management, 15 percent is in State land, and 15 percent is in private holdings. The basin is used for livestock grazing.

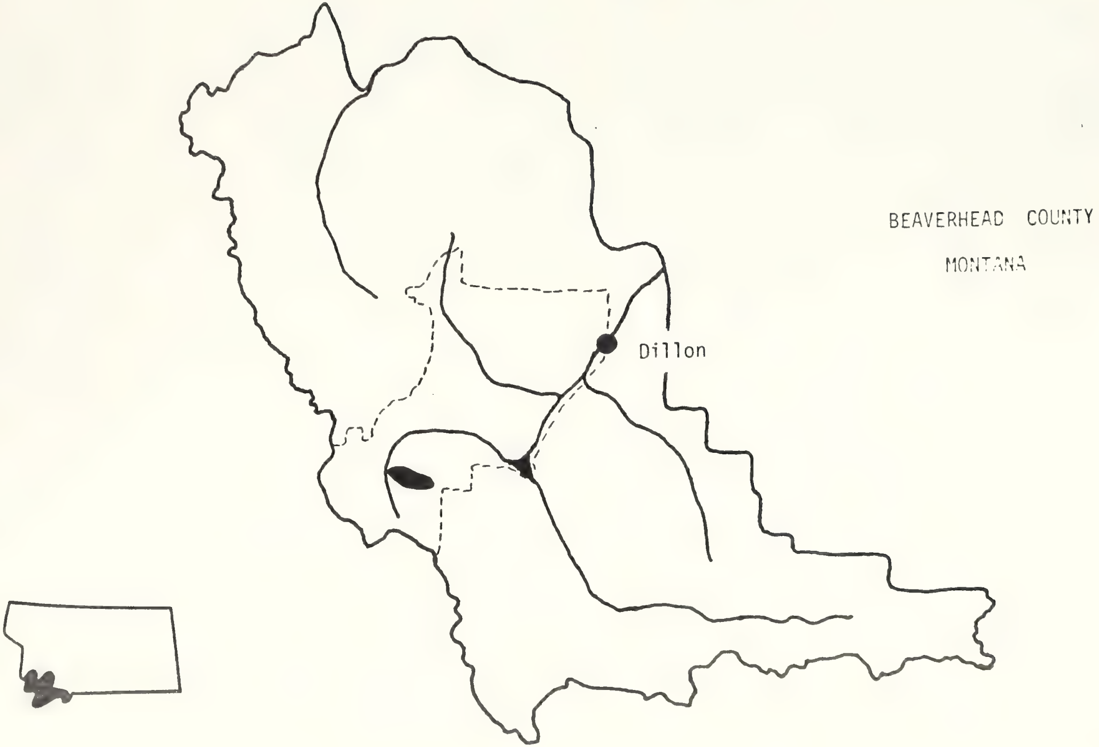

Figure 17. Location of Shenon Creek, Dillon West Planning Unit, Beaverhead County, Montana.

Lower Shenon Station

The Lower Shenon station No. 42 is located in the east central portion of Section 25, Township 10S, Range 14W (Figure 18), approximately 75 yards downstream from where the road crosses the creek. An auxiliary station is located approximately 10 yards upstream of the road crossing. This location is found on the Everson Creek, Montana 7.5 Series U.S. Geological Survey Topographic Quadrangle. The station is depicted as site No. 42 on aerial photo No. 5-118-109 of this resource inventory report, and is shown on stream station photos no. 42(A) and no. 42(B). The station is located at 6,380 ft. elevation. The watershed above the station contains approximately 5,020 acres, has a local relief of 2,940 feet, and is oriented to the west-northwest. Approximately 15 percent of the watershed is forested.

Upper Shenon Station

The Upper Shenon station No. 41 is located in the central portion of Section 33, Township 10S, Range 13W (Figure 18), approximately 800 yards downstream from the confluence of Shenon Creek and the unnamed stream entering from the south. This location is found on the Jeff Davis Peak, Montana 7.5 Series U.S. Geological Survey Topographic Quadrangle. The station is depicted as site No. 41 on aerial photo No. 5-118-111 of this resource inventory report. and is shown on stream station photos no.41(A) and no. 41(B). The station is located at 6,840 ft. elevation. The watershed above the station contains approximately 2,430 acres, has a local relief of 2,480 feet, and is oriented to the west-northwest. Approximately 30 percent of the watershed is forested.

The Upper Shenon Creek precipitation station No. 41G is located in the central portion of Section 33, Township 10S, Range 13W (Figure 18). The gauge is approximately 100 yards uphill to the north on the first level above the stream station. The station is depicted as site No. 41G on aerial photo No. 5-118-111 of this resource inventory report.

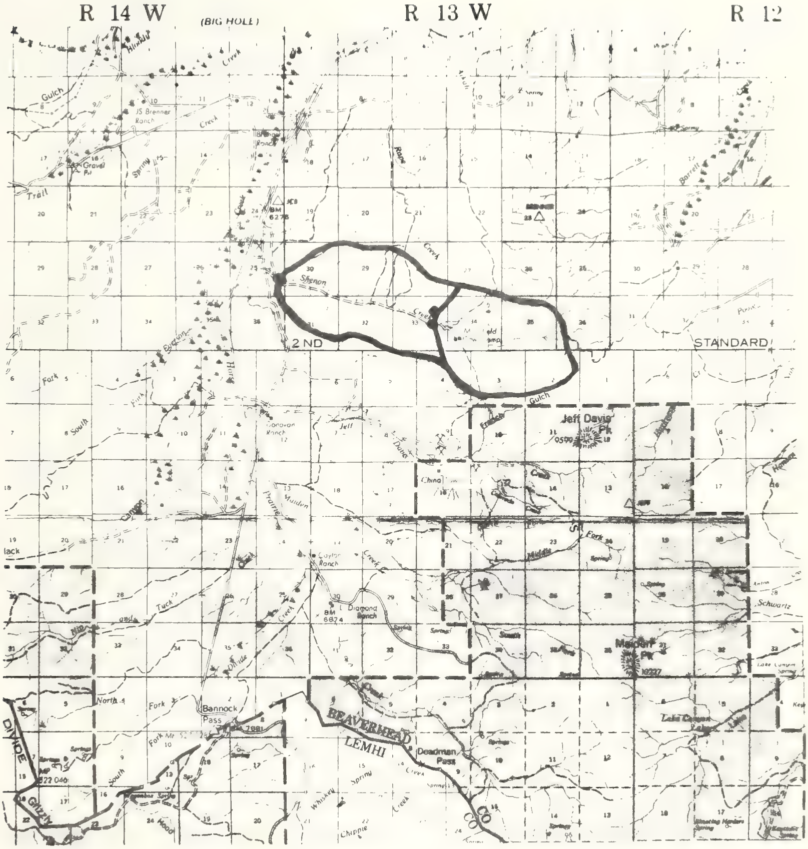

Figure 18. Location of the Shenon Creek Sampling Stations.

RESULTS AND DISCUSSION

The results of the water quality survey of the sample basins of the Dillon West Planning Unit are summarized and briefly discussed below. The basin data for each station is found in the Appendix of this volume.

Taylor Creek Basin

The Taylor Creek sample basin was visited a toal of 17 and 19 times during the two hydrologic years. There were no specific accessibility problems; however, residual channel ice during 1977 did present some sampling problems during the early spring. The Upper Taylor station was visited 15 and 16 times, while the intermittent Middle Taylor station was monitored 8 and 13 times respectively.

Channel Stability Ratings

The Lower Taylor Creek, Middle Taylor Creek, and Upper Taylor Creek stream sections were evaluated on August 16, 1976. The lower portion of Taylor Creek between the highway and the old Big Hole Road was rated as 'good' (75) (Table 1), the middle segment from the road to a point where Taylor Creek crosses the eastern boundary of Section 6, was rated as 'Fair' (94) (Table 2), while the upper segment to the Beaverhead National Forest boundary was rated as 'poor' (116) (Table 3).

Precipitation

Precipitation was measured at the Upper Taylor precipitation station from April 22 through November 12, 1977 and from April 21 through September 15, 1978. The general precipitation patterns during these two fiscal years

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Table 1 R-1 STREAM CHANNEL STABILITY FIELD EVALUATION FORM

Lower Taylor
8/16/76

Item Rated	Stability Indicators by Classes							
	EXCELLENT		GOOD		FAIR		POOR	
I. UPPER BANKS								
Landform Slope	Bank slope gradient <30%	(2)	Bank slope gradient 30-40%	(3)	Bank slope gradient 40-60%	(6)	Bank slope gradient 60% +	8
Mass Wasting (Existing or Potential)	No evidence of past or potential for future mass wasting into channels.	(3)	Infrequent and/or very small. Mostly healed over. Low future potential.	(6) 4	Moderate frequency & size, with some raw spots eroded by water during high flows.	(9)	Frequent or large, causing sediment nearly yearlong OR imminent danger of same.	12
Debris Jam Potential (Floatable Objects)	Essentially absent from immediate channel area.	(2)	Present but mostly small twigs and limbs.	(4)	Present, volume and size are both increasing.	(6)	Moderate to heavy amounts, predominantly larger sizes.	8
Bank Protection from Vegetation	90% + plant density. Vigor and variety suggests a deep, dense root mass.	(3)	70-90% density. Fewer plant species or lower vigor suggests a less dense or deep root mass.	(6)	50-70% density. Lower vigor and still fewer species form a somewhat shallow and discontinuous root mass.	(9)	<50% density plus fewer species & less vigor indicate poor, discontinuous, and shallow root mass.	12
II. LOWER BANKS								
Channel Capacity	Ample for present plus some increases. Peak flows contained. W/D ratio <7.	(1)	Adequate. Overbank flows rare. Width to Depth (W/D) ratio 8-15.	(2)	Barely contains present peaks. Occasional overbank floods. W/D ratio 15-25.	(3)	Inadequate. Overbank flows common. W/D ratio >25.	4
Bank Rock Content	65% + with large, angular boulders 12" + numerous.	(2)	40 to 65%, mostly small boulders to cobble 6-12".	(4)	20 to 40%, with most in the 3-6" diameter class.	(6) 5	<20% rock fragments of gravel sizes, 1-3" or less.	8
Obstructions Flow Deflectors Sediment Traps	Rocks, old logs firmly embedded. Flow pattern of pool & riffles stable without cutting or deposition.	(2)	Some present, causing erosive cross currents and minor pool filling. Obstructions and deflectors newer and less firm.	(4) 3	Moderately frequent, moderately unstable obstructions & deflectors move with high water causing bank cutting and filling of pools.	(6)	Frequent obstructions and deflectors cause bank erosion yearlong. Sed. traps full, channel migration occuring.	8
Cutting	Little or none evident. Infrequent raw banks less than 6" high generally.	(4)	Some, intermittently at outcurves & constrictions. Raw banks may be up to 12".	(8) 7	Significant. Cuts 12"-24" high. Root mat overhangs and sloughing evident.	(12)	Almost continuous cuts, some over 24" high. Failure of overhangs frequent.	16
Deposition	Little or no enlargement of channel or point bars.	(4)	Some new increas in bar formation, most from coarse gravels.	(8) 7	Moderate deposition of new gravel & coarse sand on old and some new bars.	(12)	Extensive deposits of predominately fine particles. Accelerated bar development.	16
III. BOTTOM								
Rock Angularity	Sharp edges and corners, plane surfaces roughened.	(1)	Rounded corners & edges, surfaces smooth & flat.	(2)	Corners & edges well rounded in two dimensions.	(3)	Well rounded in all dimensions, surfaces smooth.	4
Brightness	Surfaces dull, darkened, or stained. Gen. not "bright".	(1)	Mostly dull but may have up to 35% bright surfaces.	(2)	Mixture, 50-50% dull and bright, ± 15%, ie 35-65%.	(3)	Predominately bright, 65% +, exposed or scoured surfaces.	4
Consolidation or Particle Packing	Assorted sizes tightly packed and/or overlapping.	(2)	Moderately packed with some overlapping.	(4)	Mostly a loose assortment with no apparent overlap.	(6) 5	No packing evident. Loose assortment, easily moved.	8
Bottom Size Distribution & Percent Stable Materials	No change in sizes evident. Stable materials 80-100%.	(4)	Distribution shift slight. Stable materials 50-80%.	(8)	Moderate change in sizes. Stable materials 20-50%.	(12) 9	Marked distribution change. Stable materials 0-20%.	16
Scouring and Deposition	Less than 5% of the bottom affected by scouring and deposition.	(6)	5-30% affected. Scour at constrictions and where grades steepen. Some deposition in pools.	(12)	30-50% affected. Deposits & scour at obstructions, constrictions, and bends. Some filling of pools.	(18)	More than 50% of the bottom in a state of flux or change nearly yearlong.	24
Clinging Aquatic Vegetation (Moss & Algae)	Abundant. Growth largely moss like, dark green, perennial. In swift water too.	(1)	Common. Algal forms in low velocity & pool areas. Moss here too and swifter waters.	(2)	Present but spotty, mostly in backwater areas. Seasonal blooms make rocks slick.	(3)	Perennial types scarce or absent. Yellow-green, short term bloom may be present.	4
COLUMN TOTALS →		−		50		25		−

Add the values in each column for a total reach score here. (E. − + G. 50 + F. 25 + P. − = 75).

Reach score of: <38=Excellent, 39-76=Good, 77-114= Fair, 115+=Poor.

R1-2500-5 (6

[illegible]

Table 2 R-1 STREAM CHANNEL STABILITY FIELD EVALUATION FORM

Middle Taylor
8/16/76

Item Rated	Stability Indicators by Classes							
I. UPPER BANKS	EXCELLENT		GOOD		FAIR		POOR	
Landform Slope	Bank slope gradient <30%	(2)	Bank slope gradient 30-40%	(4)	Bank slope gradient 40-60%	(6)	Bank slope gradient 60% +	8
Mass Wasting (Existing or Potential)	No evidence of past or potential for future mass wasting into channels.	(3)	Infrequent and/or very small. Mostly healed over. Low future potential.	(6) 4	Moderate frequency & size, with some raw spots eroded by water during high flows.	(9)	Frequent or large, causing sediment nearly yearlong OR imminent danger of same.	12
Debris Jam Potential (Floatable Objects)	Essentially absent from immediate channel area.	(2)	Present but mostly small twigs and limbs.	(4)	Present, volume and size are both increasing.	(6) 5	Moderate to heavy amounts, predominantly larger sizes.	8
Bank Protection from Vegetation	90% + plant density. Vigor and variety suggests a deep, dense root mass.	(3)	70-90% density. Fewer plant species or lower vigor suggests a less dense or deep root mass.	(6)	50-70% density. Lower vigor and still fewer species form a somewhat shallow and discontinuous root mass.	(9) 7	< 50% density plus fewer species & less vigor indicate poor, discontinuous, and shallow root mass.	12
II. LOWER BANKS								
Channel Capacity	Ample for present plus some increases. Peak flows contained. W/D ratio < 7.	(1)	Adequate. Overbank flows rare. Width to Depth (W/D) ratio 8-15.	(2)	Barely contains present peaks. Occasional overbank floods. W/D ratio 15-25.	(3)	Inadequate. Overbank flows common. W/D ratio >25.	4
Bank Rock Content	65% + with large, angular boulders 12" + numerous.	(2)	40 to 65%, mostly small boulders to cobble 6-12".	(4)	20 to 40%, with most in the 3-6" diameter class.	(6) 5	< 20% rock fragments of gravel sizes, 1-3" or less.	8
Obstructions Flow Deflectors Sediment Traps	Rocks, old logs firmly embedded. Flow pattern of pool & riffles stable without cutting or deposition.	(2)	Some present, causing erosive cross currents and minor pool filling. Obstructions and deflectors newer and less firm.	(4)	Moderately frequent, moderately unstable obstructions & deflectors move with high water causing bank cutting and filling of pools.	(6)	Frequent obstructions and deflectors cause bank erosion yearlong. Sed. traps full, channel migration occuring.	8
Cutting	Little or none evident. Infrequent raw banks less than 6" high generally.	(4)	Some, intermittently at outcurves & constrictions. Raw banks may be up to 12".	(8)	Significant. Cuts 12"-24" high. Root mat overhangs and sloughing evident.	(12) 10	Almost continuous cuts, some over 24" high. Failure of overhangs frequent.	16
Deposition	Little or no enlargement of channel or point bars.	(4)	Some new increas in bar formation, most from coarse gravels.	(8)	Moderate deposition of new gravel & coarse sand on old and some new bars.	(12) 11	Extensive deposits of predominately fine particles. Accelerated bar development.	16
III. BOTTOM								
Rock Angularity	Sharp edges and corners, plane surfaces roughened.	(1)	Rounded corners & edges, surfaces smooth & flat.	(2)	Corners & edges well rounded in two dimensions.	(3)	Well rounded in all dimensions, surfaces smooth.	4
Brightness	Surfaces dull, darkened, or stained. Gen. not "bright".	(1)	Mostly dull but may have up to 35% bright surfaces.	(2)	Mixture, 50-50% dull and bright, ± 15%, ie 35-65%.	(3)	Predominately bright, 65% +, exposed or scoured surfaces.	4
Consolidation or Particle Packing	Assorted sizes tightly packed and/or overlapping.	(2)	Moderately packed with some overlapping.	(4)	Mostly a loose assortment with no apparent overlap.	(6) 5	No packing evident. Loose assortment, easily moved.	8
Bottom Size Distribution & Percent Stable Materials	No change in sizes evident. Stable materials 80-100%.	(4)	Distribution shift slight. Stable materials 50-80%.	(8)	Moderate change in sizes. Stable materials 20-50%.	(12) 11	Marked distribution change. Stable materials 0-20%.	16
Scouring and Deposition	Less than 5% of the bottom affected by scouring and deposition.	(6)	5-30% affected. Scour at constrictions and where grades steepen. Some deposition in pools.	(12)	30-50% affected. Deposits & scour at obstructions, constrictions, and bends. Some filling of pools.	(18) 16	More than 50% of the bottom in a state of flux or change nearly yearlong.	24
Clinging Aquatic Vegetation (Moss & Algae)	Abundant. Growth largely moss like, dark green, perennial. In swift water too.	(1)	Common. Algal forms in low velocity & pool areas. Moss here too and swifter waters.	(2)	Present but spotty, mostly in backwater areas. Seasonal blooms make rocks slick.	(3)	Perennial types scarce or absent. Yellow-green, short term bloom may be present.	4
	COLUMN TOTALS →	–	→	14	→	76	→	4

Add the values in each column for a total reach score here. (E. – + G. 14 + F. 76 + P. 4 = 94).

Reach score of: <38=Excellent, 39-76 =Good, 77-114= Fair, 115+=Poor.

R1-2500-5 (6

Table 3 R-1 STREAM CHANNEL STABILITY FIELD EVALUATION FORM

Upper Taylor
8/16/7o

Item Rated	Stability Indicators by Classes							
	EXCELLENT		GOOD		FAIR		POOR	
I. UPPER BANKS								
Landform Slope	Bank slope gradient <30%	(2)	Bank slope gradient 30-40%	(3)	Bank slope gradient 40-60%	(6)	Bank slope gradient 60% +	8
Mass Wasting (Existing or Potential)	No evidence of past or potential for future mass wasting into channels.	(3)	Infrequent and/or very small. Mostly healed over. Low future potential.	(4)	Moderate frequency & size, with some raw spots eroded by water during high flows.	(9)	Frequent or large, causing sediment nearly yearlong OR imminent danger of same.	12
Debris Jam Potential (Floatable Objects)	Essentially absent from immediate channel area.	(2)	Present but mostly small twigs and limbs.	(4)	Present, volume and size are both increasing.	(6)	Moderate to heavy amounts, predominantly larger sizes.	8 (7)
Bank Protection from Vegetation	90% + plant density. Vigor and variety suggests a deep, dense root mass.	(3)	70-90% density. Fewer plant species or lower vigor suggests a less dense or deep root mass.	(6)	50-70% density. Lower vigor and still fewer species form a somewhat shallow and discontinuous root mass.	(9) (8)	<50% density plus fewer species & less vigor indicate poor, discontinuous, and shallow root mass.	12
II. LOWER BANKS								
Channel Capacity	Ample for present plus some increases. Peak flows contained. W/D ratio <7.	(1)	Adequate. Overbank flows rare. Width to Depth (W/D) ratio 8-15.	(2)	Barely contains present peaks. Occasional overbank floods. W/D ratio 15-25.	(3)	Inadequate. Overbank flows common. W/D ratio >25.	4
Bank Rock Content	65% + with large, angular boulders 12" + numerous.	(2)	40 to 65%, mostly small boulders to cobble 6-12".	(4)	20 to 40% , with most in the 3-6" diameter class.	(6)	<20% rock fragments of gravel sizes, 1-3" or less.	8 (7)
Obstructions Flow Deflectors Sediment Traps	Rocks, old logs firmly embedded. Flow pattern of pool & riffles stable without cutting or deposition.	(2)	Some present, causing erosive cross currents and minor pool filling. Obstructions and deflectors newer and less firm.	(4)	Moderately frequent, moderately unstable obstructions & deflectors move with high water causing bank cutting and filling of pools.	(6)	Frequent obstructions and deflectors cause bank erosion yearlong. Sed. traps full, channel migration occuring.	8 (7)
Cutting	Little or none evident. Infrequent raw banks less than 6" high generally.	(4)	Some, intermittently at outcurves & constrictions. Raw banks may be up to 12".	(8)	Significant. Cuts 12"-24" high. Root mat overhangs and sloughing evident.	(12)	Almost continuous cuts, some over 24" high. Failure of overhangs frequent.	16 (13)
Deposition	Little or no enlargement of channel or point bars.	(4)	Some new increas in bar formation, most from coarse gravels.	(8)	Moderate deposition of new gravel & coarse sand on old and some new bars.	(12)	Extensive deposits of predominately fine particles. Accelerated bar development.	16 (13)
III. BOTTOM								
Rock Angularity	Sharp edges and corners, plane surfaces roughened.	(1)	Rounded corners & edges, surfaces smooth & flat.	(2)	Corners & edges well rounded in two dimensions.	(3)	Well rounded in all dimensions, surfaces smooth.	4
Brightness	Surfaces dull, darkened, or stained. Gen. not "bright".	(1)	Mostly dull but may have up to 35% bright surfaces.	(2)	Mixture, 50-50% dull and bright, ± 15%, ie 35-65%.	(3)	Predominately bright, 65% +, exposed or scoured surfaces.	(4)
Consolidation or Particle Packing	Assorted sizes tightly packed and/or overlapping.	(2)	Moderately packed with some overlapping.	(4)	Mostly a loose assortment with no apparent overlap.	(6)	No packing evident. Loose assortment, easily moved.	8
Bottom Size Distribution & Percent Stable Materials	No change in sizes evident. Stable materials 80-100%.	(4)	Distribution shift slight. Stable materials 50-80%.	(8)	Moderate change in sizes. Stable materials 20-50%.	(12)	Marked distribution change. Stable materials 0-20%.	16 (14)
Scouring and Deposition	Less than 5% of the bottom affected by scouring and deposition.	(6)	5-30% affected. Scour at constrictions and where grades steepen. Some deposition in pools.	(12)	30-50% affected. Deposits & scour at obstructions, constrictions, and bends. Some filling of pools.	(18)	More than 50% of the bottom in a state of flux or change nearly yearlong.	24 (20)
Clinging Aquatic Vegetation (Moss & Algae)	Abundant. Growth largely moss like, dark green, perennial. In swift water too.	(1)	Common. Algal forms in low velocity & pool areas. Moss here too and swifter waters.	(2)	Present but spotty, mostly in backwater areas. Seasonal blooms make rocks slick.	(3)	Perennial types scarce or absent. Yellow-green, short term bloom may be present.	(4)
COLUMN TOTALS →		-	→	7	→	20	→	89

Add the values in each column for a total reach score here. (E. - + G. 7 + F. 20 + P. 89 = 116).

Reach score of: <38=Excellent, 39-76=Good, 77-114= Fair, 115+=Poor.

R1-2500-5 (6

are compared to those of the Dillon and Lima weather stations (Figure 19). Apparently 1977 was the wetter field season, although the snow pack on Baldy Mountain was greater for the 1978 hydrologic year.

Stream Discharge

The staff-discharge rating curves for the Lower Taylor, and Upper Taylor sample stations are presented in Figures 20 and 21. The gauging sites remained nearly stable during the two sampling years, except for the late summer months of 1978 at the lower station where dense algal growth affected stage readings. The channel cross section at the Middle Taylor station was so unstable that a staff discharge rating curve could not be developed.

The 1977 and 1978 annual hydrographs for the Lower Taylor, Middle Taylor, and Upper Taylor Creek sampling stations are presented in Figures 22-27. Peak flow during 1977 at the Lower Taylor station apparently took place in mid- to late April at an estimated crest stage value of 7.2 cfs, although a higher flow may have occurred prior to the first sampling visit. The lowest recorded flow during 1977 was only 0.95 cfs during mid-July. The 1978 year produced the primary peak flow of 15 cfs in late April which preceeded a secondary peak discharge of approximately 11 cfs in late May. The lowest recorded flow for 1978 was 0.95 cfs in mid-August. The Middle Taylor station produced a 3.5 cfs recorded flow in early April, 1977 during an excessively warm period. A higher flow may also have occurred. The station experienced some flow between late March or early April and late June. In 1978, flow occurred between early April and late July or early August. A peak flow of 9.4 cfs was monitored during late April, followed by secondary peak of 7.9 cfs in late May.

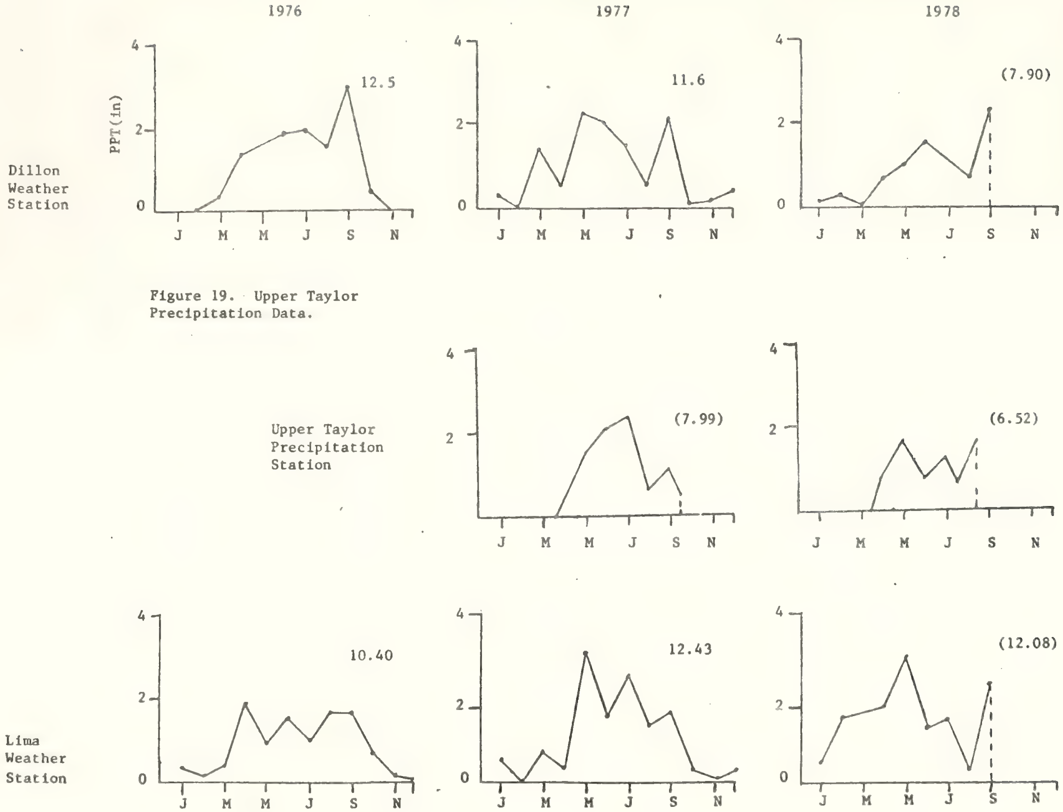


Figure 19. Upper Taylor Precipitation Data.

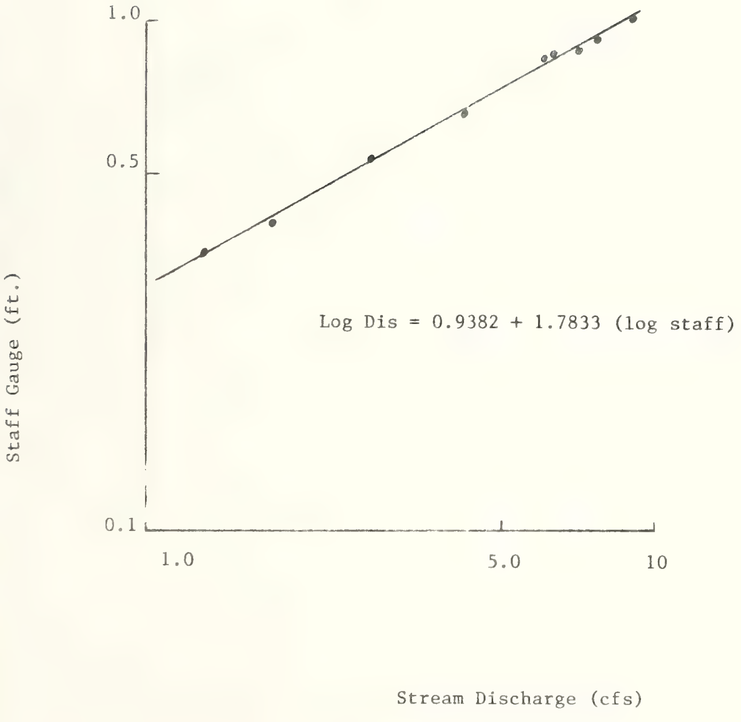
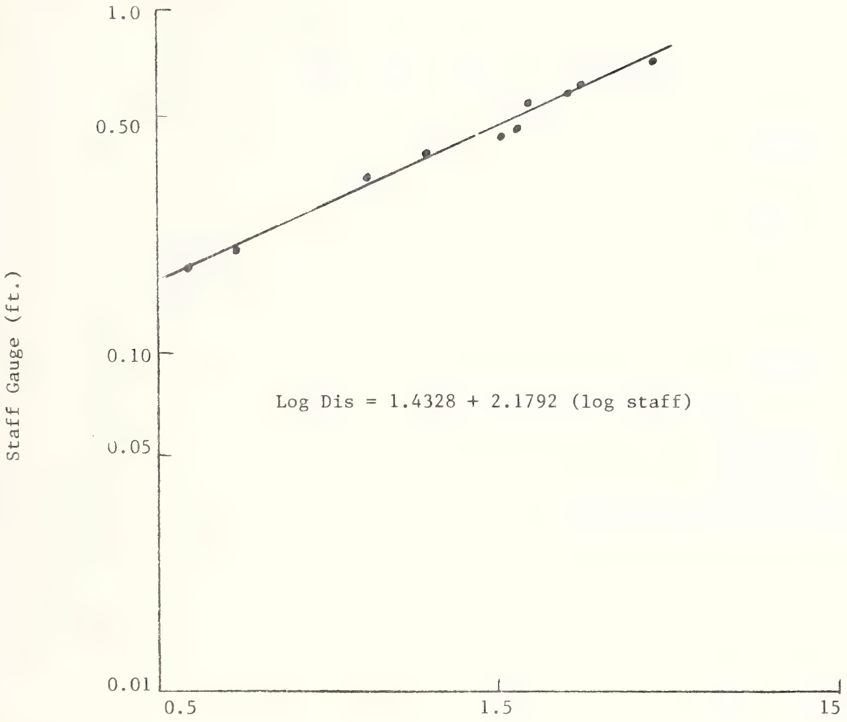


Figure 20. Staff-discharge Rating Curve for the Lower Taylor Station.



Stream Discharge (cfs)

Figure 21. Staff-discharge Rating Curve for the Upper Taylor Station.

FIGURE 22. ANNUAL HYDROGRAPH AND SEDIMENT LOADINGS

LOWER TAYLOR - 1977

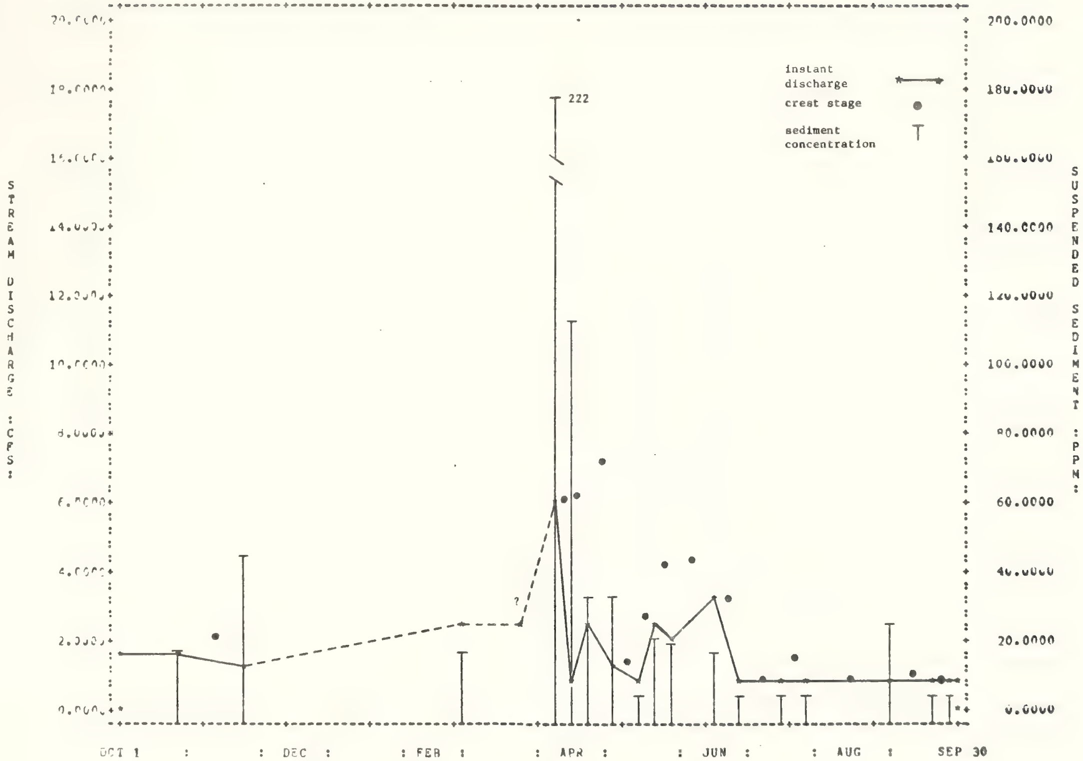


FIGURE 23. ANNUAL HYDROGRAPH AND SEDIMENT LOADINGS

LOWER TAYLOR - 1978

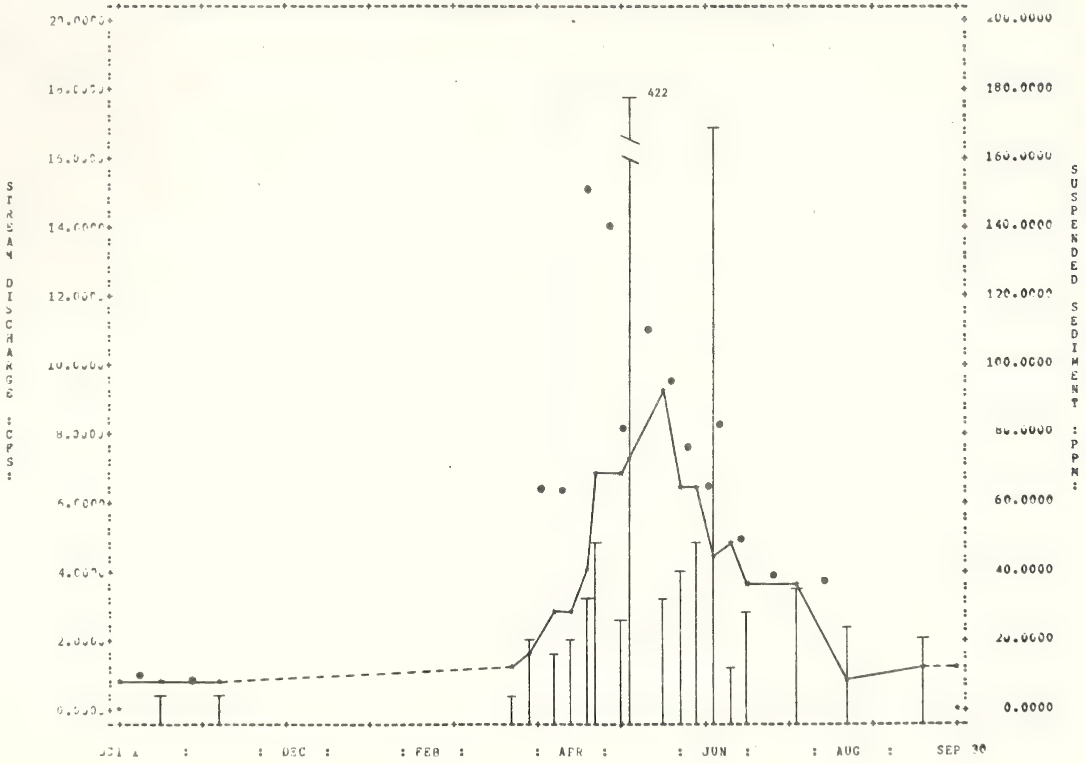


FIGURE 24. ANNUAL HYDROGRAPH AND SEDIMENT LOADINGS

MID-TAYLOR - 1977

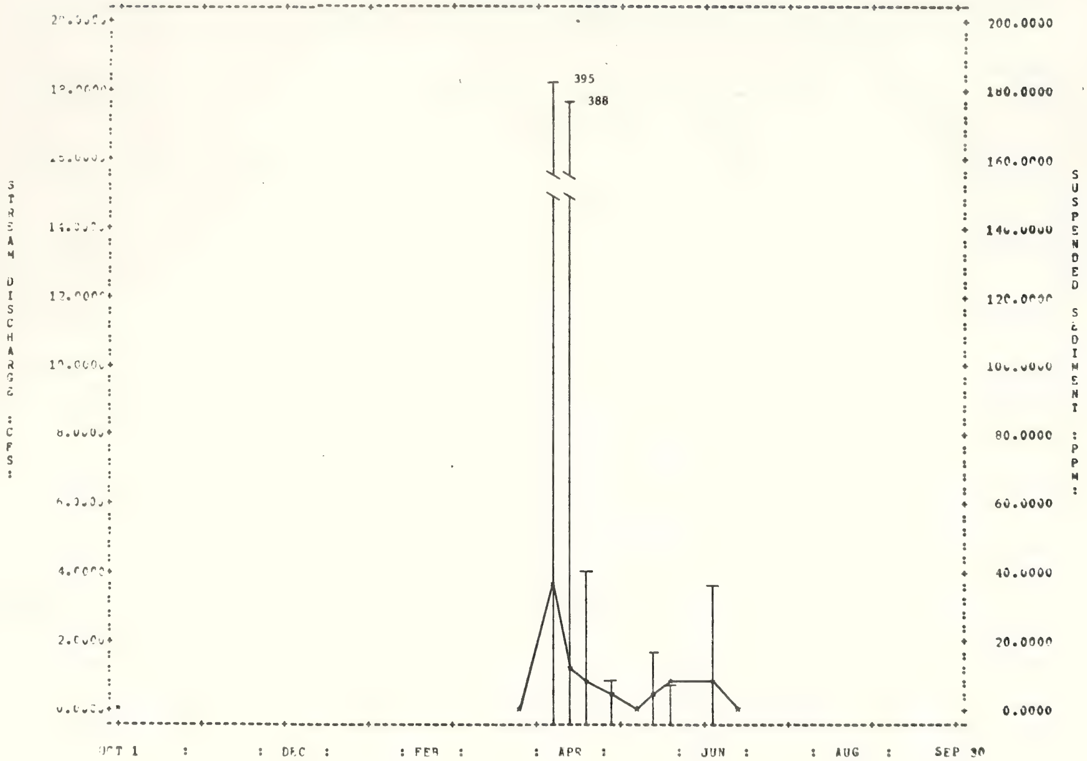


FIGURE 25. ANNUAL HYDROGRAPH AND SEDIMENT LOADINGS

MID-TAYLOR - 1976

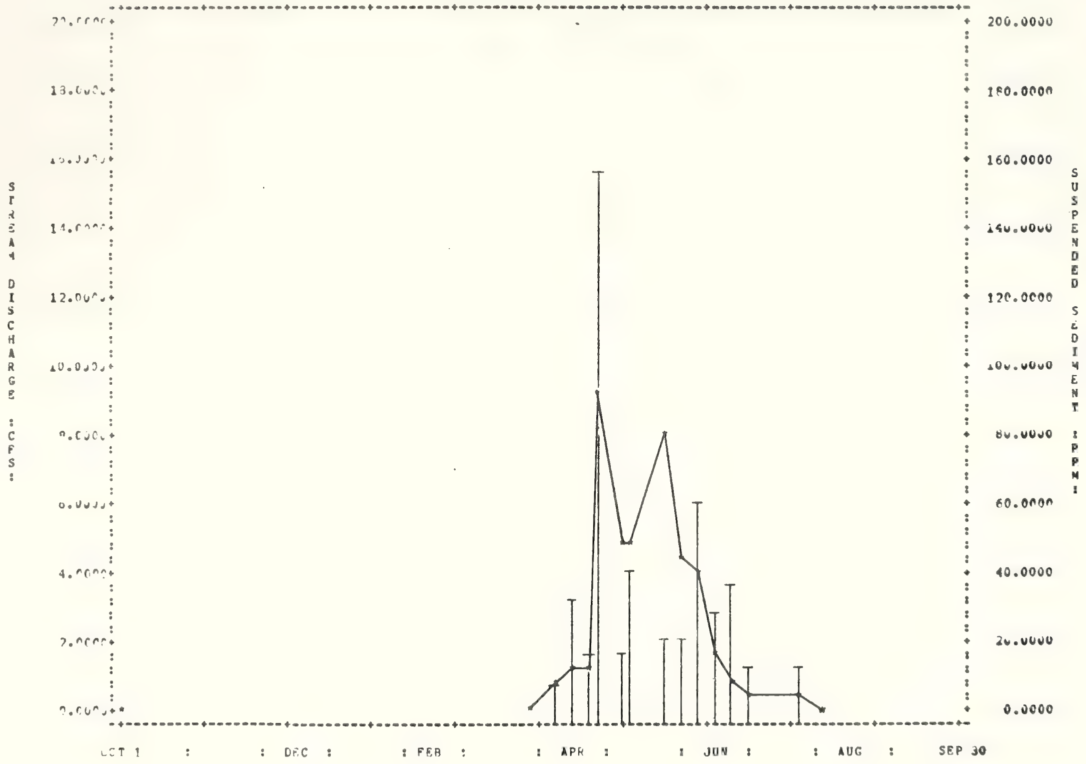


FIGURE 26. ANNUAL HYDROGRAPH AND SEDIMENT LOADINGS

UPPER TAYLOR - 1977

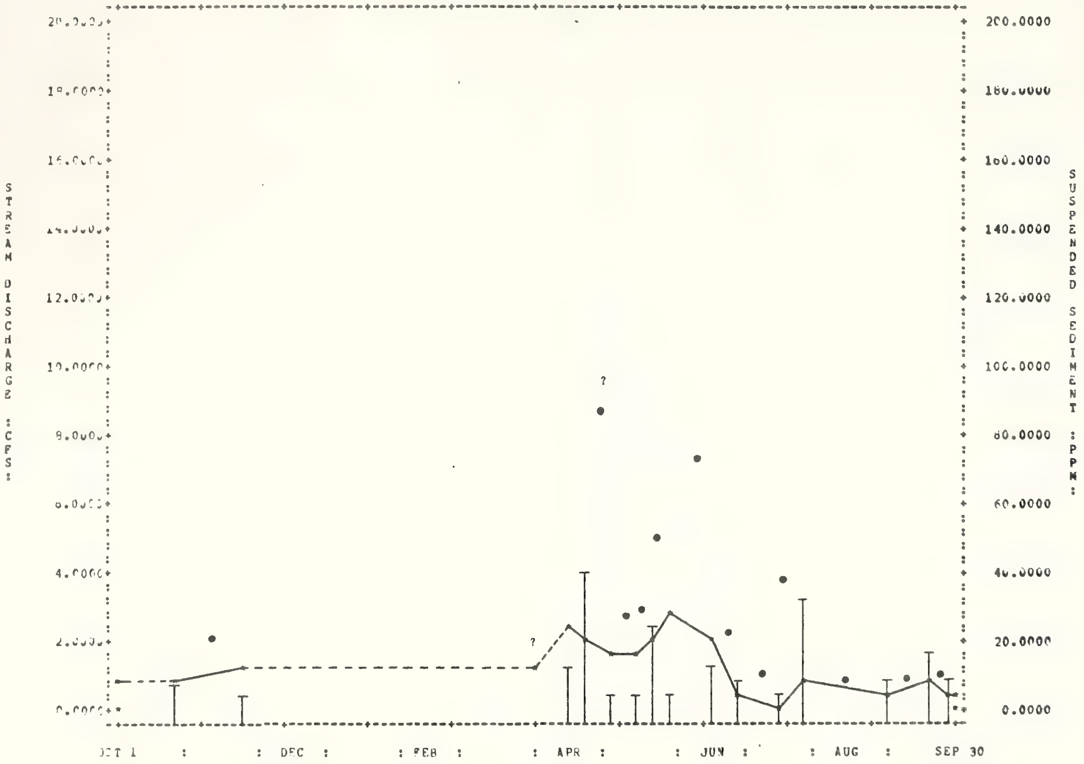
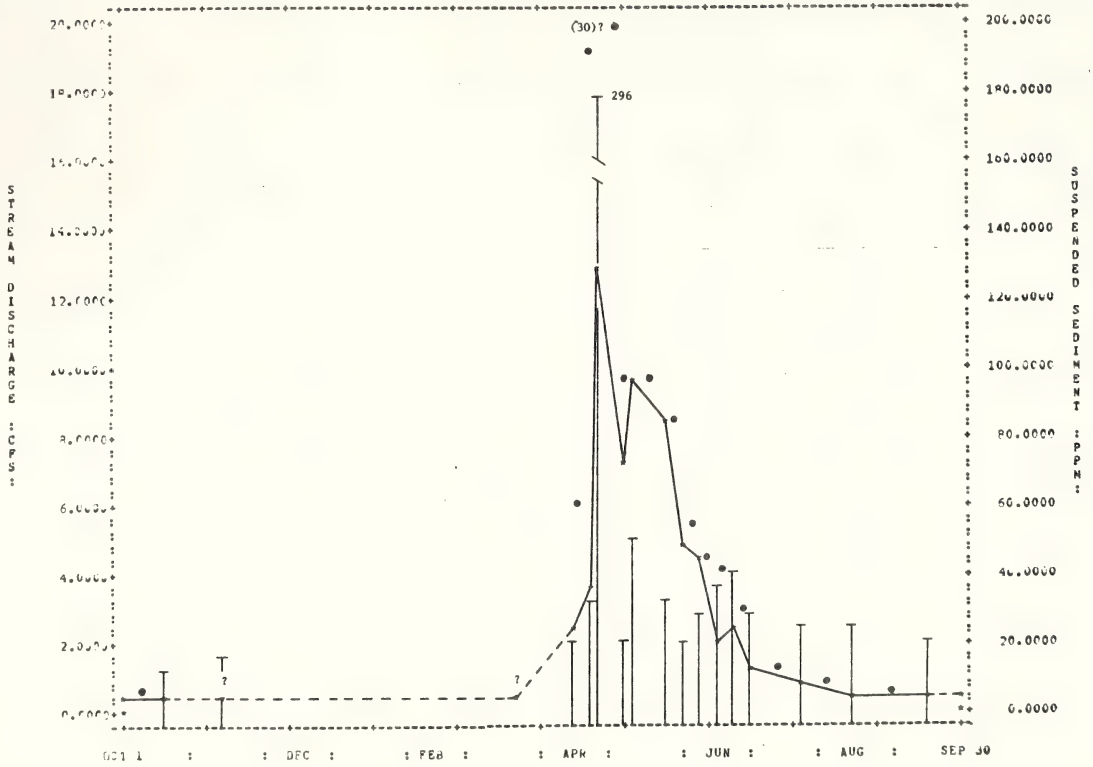


FIGURE 27. ANNUAL HYDROGRAPH AND SEDIMENT LOADINGS

UPPER TAYLOR - 1978



The Upper Taylor station had an estimated peak discharge of 8.6 cfs during mid-April, 1977, although this value could have been influenced by residual channel ice. A second peak of 7.4 cfs occurred in early June. The lowest recorded flow for the year was 0.20 cfs in mid-July. During 1978, a questionable peak of 30 cfs was estimated for early May, the highest monitored flow was 13 cfs in late April. The lowest flow was recorded at 0.30 cfs in the previous October. The differences noted in flow patterns for the two hydrologic years are largely attributed to differences in the annual precipitation and snow melt patterns.

The respective annual hydrograph data were used to estimate the annual water yields for each station (Table 4). In both water years, the estimated water yield for the Upper Taylor station averaged 65 percent of the Lower Taylor station values, approximately 1,270 acre feet and 1,800 acre feet respectively. Water yields for the intermittent Middle Taylor station were only 153 acre feet and 685 acre feet. The 1978 water yields for both Lower and Upper stations increased by nearly 50 percent.

Suspended Sediment

The annual pattern of sediment concentration for each station by hydrologic year is depicted in Figures 22-27. Suspended sediment concentrations at the Lower Taylor station ranged from <5 ppm at low flow to 482 ppm at high flow, those for the Upper station ranged from <5 ppm to 296 ppm, while concentrations at the Middle Taylor station extended from 7 ppm to 395 ppm. The relationships between suspended sediment and stream discharge for each station were statistically significant, and are presented in Figures 28-30. The Middle Taylor station exhibited the greatest variation. The variability in sediment concentration with stream flow is partially attributed to a seasonal effect, specific storm effects,

Table 4. Estimated Water and Sediment Yields for Taylor Creek Basin, 1977 - 1978.

Station Name	Water Year	Estimated Water Yield	Estimated Sediment Yield	Contributing Watershed (acres)	Runoff (in./ac.)	Sediment Yield (lbs/acre)
Lower Taylor Station	1977	1,270	71	7,740	1.97	18.4
	1978	1,800	162	7,740	2.80	41.9
Middle Taylor Station	1977	153	50	6,910	0.27	14.6
	1978	685	50	6,910	1.19	14.6
Upper Taylor Station	1977	796	11	4,420	2.16	5.07
	1978	1,210	119*	4,420	3.29	53.8

* Approximately 65 percent of yield is attributed to one 13-day flow period of high sediment concentration.

FIGURE 28. SUSPENDED SEDIMENT VS STREAM DISCHARGE - LOWER TAYLOR

LOG SED = 1.0041 + 0.9357(LOG DIS)

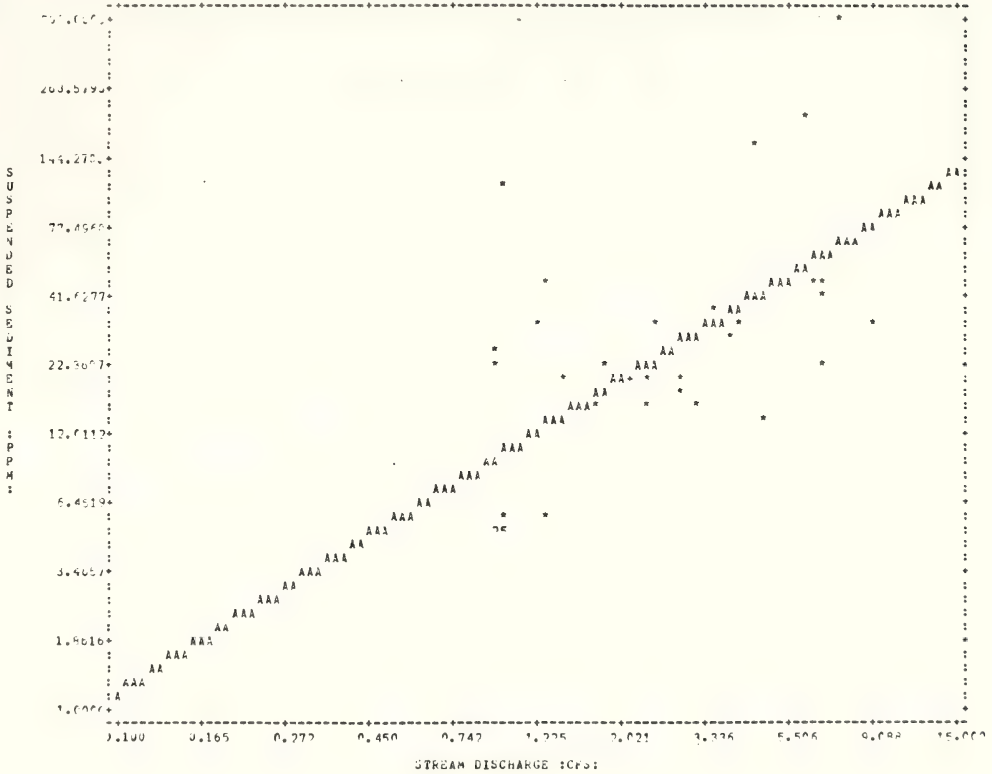


FIGURE 29. SUSPENDED SEDIMENT VS STREAM DISCHARGE - MIDDLE TAYLOR

LOG SED = 1.3988 + 0.4985(LOG DIS)

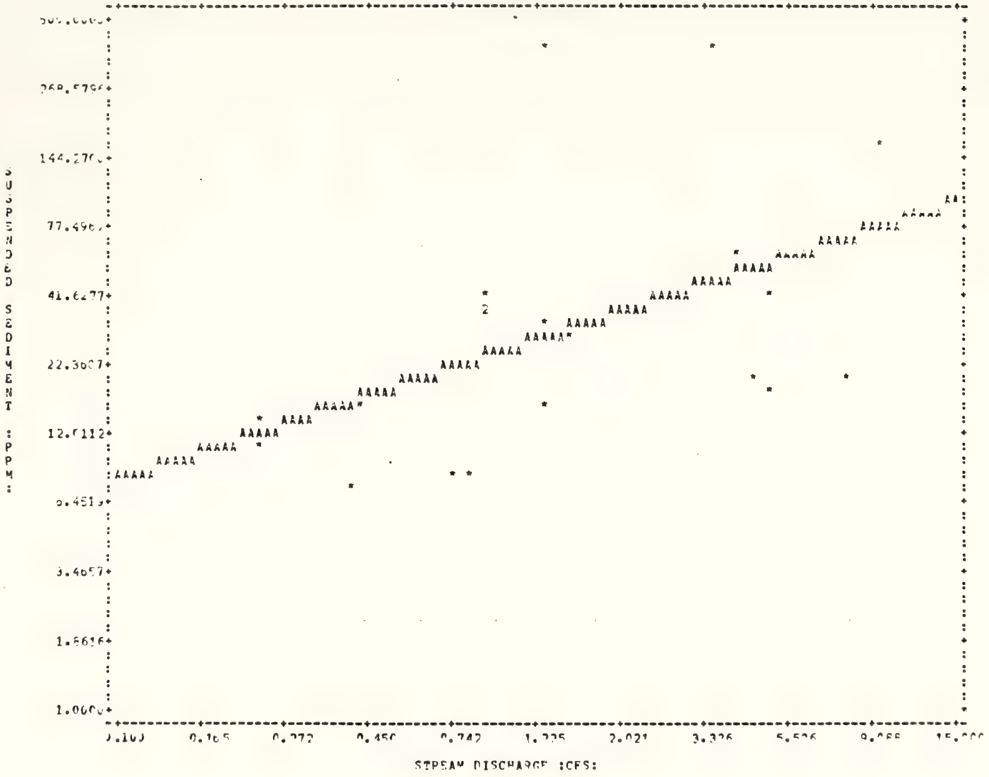
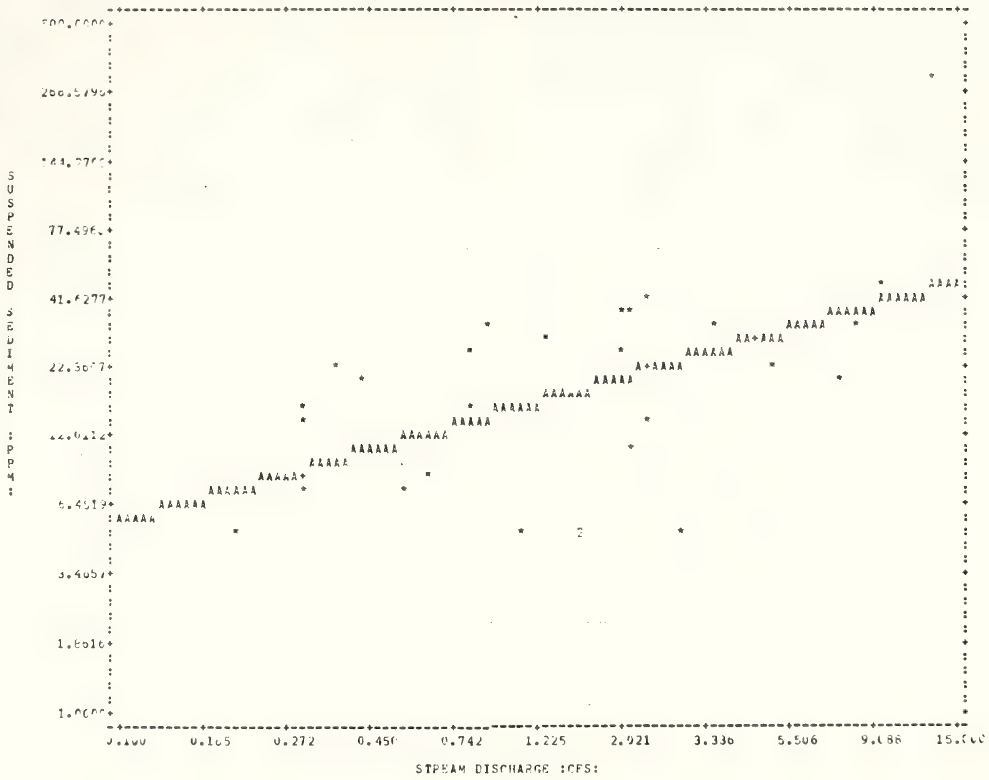


FIGURE 30. SUSPENDED SEDIMENT VS STREAM DISCHARGE - UPPER TAYLOR

LOG SED = 1.1712 + 0.4346(LOG DIS)



the presence of livestock and to the hysteresis effect, whereby peak concentrations of suspended sediment generally occur prior to peak runoff during the rising stage (Gregory and Walling, 1973, pp. 215-219). Annual sediment yields for the three sampling stations were estimated from respective water yield and sediment concentration data (Table 4). The Lower Taylor station produced approximately 71 tons and 162 tons of suspended sediment during the two sample years. Middle Taylor was estimated to have generated approximately 50 tons each year. The high sediment concentrations during the early 1977 season account for this condition. Sediment yields for the upper station were estimated at 11 tons and 119 tons respectively, however 65 percent of the 1978 yield is attributable to one 13-day flow period encompassing April 27th and thus may be overestimated.

Hydrochemical Parameters

The concentration of dissolved solids is inversely related to stream discharge so that lower concentrations occur during periods of high runoff, while higher concentrations are found during periods of low summer base flow (Gunnerson, 1967; Gregory and Walling, 1973, pp. 219-225). Patterns for specific ions, especially the ecologically important ones, often vary from this generalization (Likens, et al., 1977, pp. 74-76).

Specific conductance for the Lower Taylor station ranged from a low of 95 umhos during high spring runoff to a high of 210 umhos, the Middle and Upper Taylor stations had much lower values ranging from 21 umhos to 35 umhos and 17 umhos to 53 umhos respectively. The relationships between specific conductance and stream discharge for each station were statistically significant and are presented in Figures 31-33. Variation in specific conductance

FIGURE 31. CONDUCTIVITY VS STREAM DISCHARGE - LOWER TAYLOR

LOG CON = 2.3259 - 0.3121(LOG DIS)

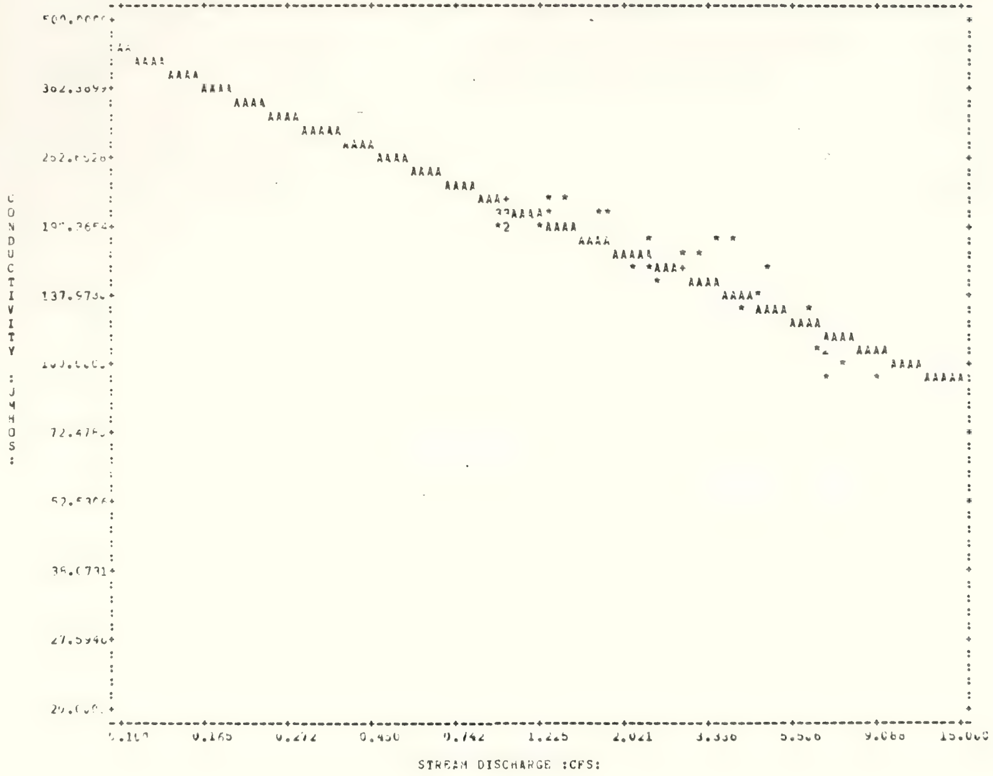


FIGURE 32. CONDUCTIVITY VS STREAM DISCHARGE - MIDDLE TAYLOR

LOG COND = 1.8222 - 0.0953(LOG DIS)

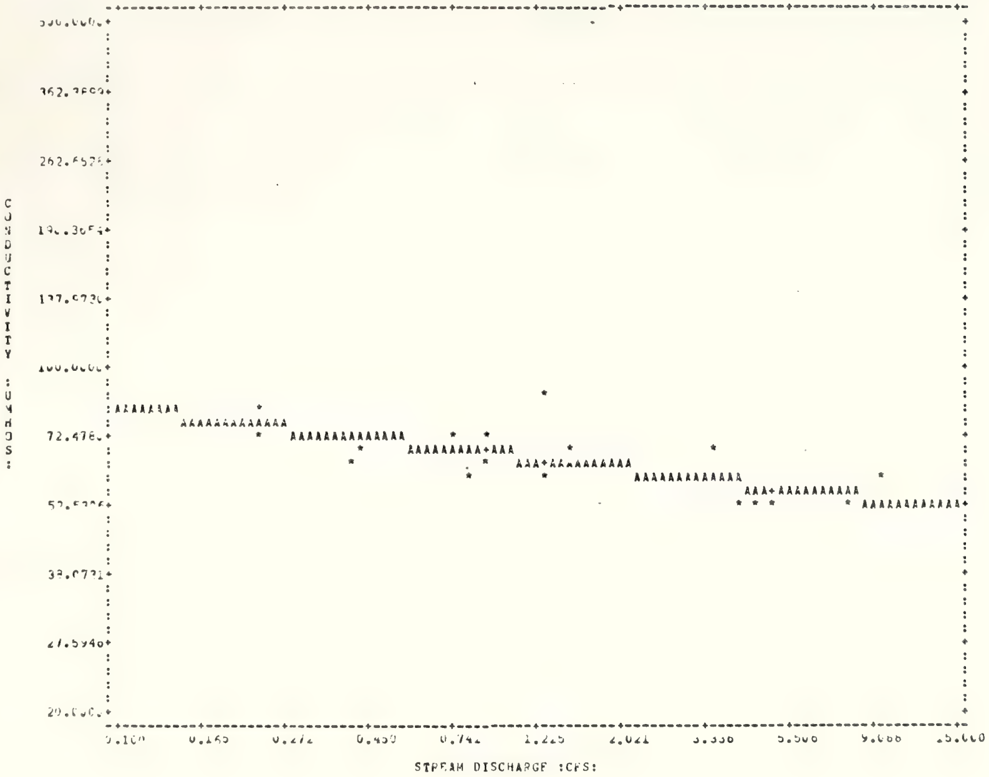


FIGURE 33. CONDUCTIVITY VS STREAM DISCHARGE - UPPER TAYLOR

LOG COND = 1.8405 - 0.1666(LOG DIS)

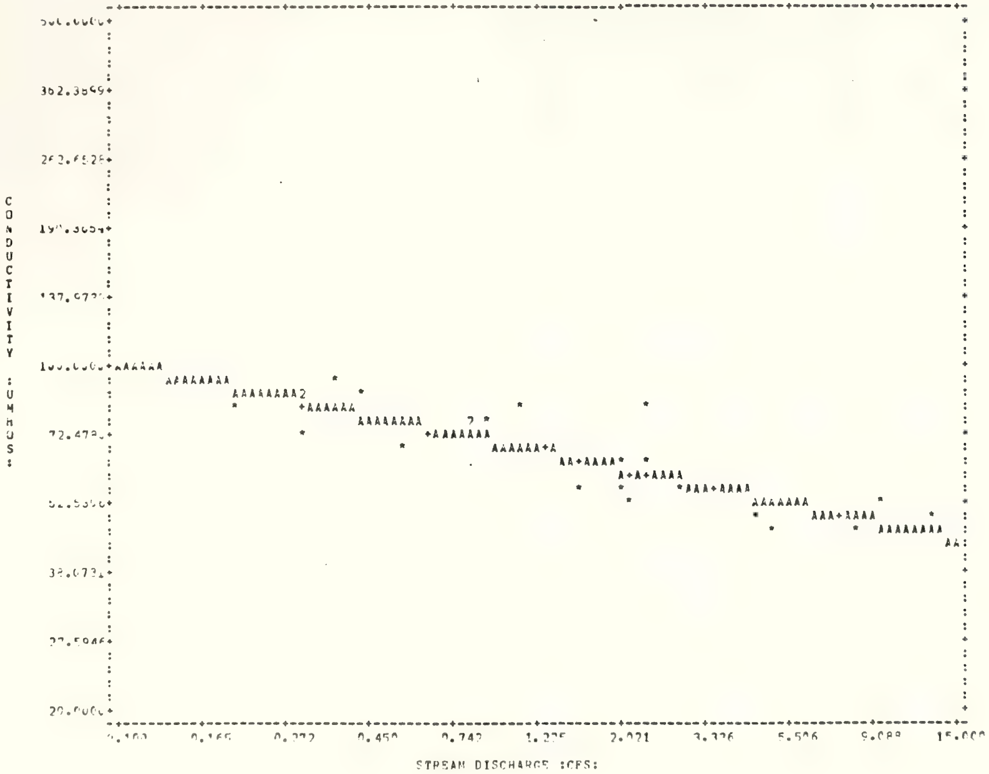


Table 5. Ranges of Hydrochemical Characteristics for Taylor Creek Sampling Stations, 1977 - 1978.

	Lower Taylor	Middle Taylor	Upper Taylor
pH	6.45 - 8.55	6.00 - 7.70	6.10 - 7.61
Alkalinity ($CaCO_3$) (mg/l)	44 - 130	21 - 35	17 - 53
Specific Conductance (μmhos)	95 - 210	51 - 87	46 - 91
Total Dissolved Solids (mg/l)	62 - 136	33 - 57	30 - 59
Ca (mg/l)	13 - 36	7.2 - 16	5.9 - 12
Mg (mg/l)	3.1 - 11	1.7 - 5.7	1.4 - 3.7
Na (mg/l)	2.4 - 3.7	2.1 - 3.4	1.9 - 4.4
K (mg/l)	.96 - 1.6	1.0 - 2.2	1.0 - 2.6
HCO_3 (mg/l)	50 - 158	25 - 43	36 - 65
SO_4 (mg/l)	2 - 7	1 - 7	2 - 6
NH_4 (mg/l)	$<$ .01 - (.29)	$<$ .01 - .17	$<$ .01 - (.20)
NO_2 + NO_3 - N (mg/l)	.02 - .46	$<$ .01 - .10	$<$ .01 - .12
PO_4 (Ortho) - P (mg/l)	T - .045	.008 - .040	.007 - .062

with stream discharge is partially attributed to seasonal and storm hysteresis effects (Gregory and Walling, 1973, pp. 219-225). The ranges in ionic concentration for specific ions are presented in Table 5.

Bacteria Levels

The concentration of fecal and total coliform in streams draining rangeland watersheds is directly related to the number of cattle present, their access to the stream, the physical and hydrological characteristics of the basin, local weather conditions (Kunkle, 1970; Stephensen and Street, 1978), and the time of day (Kunkle and Meiman, 1968). Seasonal patterns include a spring "flushing" effect during the rising stage (Kunkle and Meiman, 1968), with high counts during the low flow summer period, counts which often continue for some period after the cattle have been removed from the area (Stephensen and Street, 1978). This seasonal pattern may briefly be modified by local storms which produce their own "flushing" effect, and which may or may not be followed by a short term dilution period.

The concentrations of fecal coliform for the Taylor Creek sampling stations for the study period are presented in Table 5a. Higher values occurred during the grazing season, especially with the know presence of livestock. The data infer that livestock were present above the Upper station. Maximum fecal coliform levels were 1,020, 10,900 and TNTC (colonies/100 mls) respectively for each station. Approximately 15 percent, 40 percent, and 45 percent of the sample coliform counts exceeded the 200 colony/100 ml limit of the Montana Water Quality Criteria. Low values were associated with the spring season.

Table 5a. Fecal Coliform Counts (colonies/100 mls) for the Taylor Creek Sampling Stations, 1977 - 1978.

	Lower Taylor		Middle Taylor		Upper Taylor	
	1977	1978	1977	1978	1977	1978
April		10		20		10
May	10	9*	< 2	5	< 2	34
June	22(?)	340*		10,900*	126*	17
July	67(?)	1020*		1,400(?)	TNTC*	230(?)
August	5*	47(?)			700(?)	200(?)
September	47(?)	13(?)			34(?)	217(?)
October	9				312*	
November	112				103	

* Stock visually present.

(?) Stock presence uncertain.

Comments

The Taylor Creek basin is unique in that the middle portion of the main stream remains dry for nearly two-thirds of the year, even though the Upper station averaged 65 percent of the water yield of the Lower station. Chemically the two areas are distinct, primarily owing to geologic differences. Cattle use, especially along the stream course above the Middle station, apparently influenced some sediment concentrations. Their presence is confirmed by the high fecal coliform concentrations. Because of the limited number of samples taken and the nature of the hydrochemical parameters evaluated, relationships between the water quality characteristics of the Taylor Creek and the Montana Water Quality Criteria cannot be addressed.

Dyce Creek Basin

The Dyce Creek basin was visited a total of 17 and 18 times during the two hydrologic years. There were no specific accessibility problems for the Lower East and Lower West Dyce sampling stations. Excessive residual channel ice at the initial Lower West Dyce station, accompanied by sedimentation problems, led to the movement of the station to a more open and stable site for 1978. Dense algal growth began to influence stage readings at the Lower East Dyce station late in the 1978 field season. The Upper East Dyce station was not accessible until later in the season, and then often with difficulty owing to the deteriorated condition of two bridges. Heavy snow also delayed the initiation of sampling at the Upper West Dyce station. Generally low flows and an unstable channel cross section created sampling problems at this station. The Upper East Dyce and Upper West Dyce sampling stations were visited 11 and 14 times during 1977, and 11 and 12 times respectively during 1978.

Channel Stability Ratings

The Upper East Dyce and Upper West Dyce stream sections above the Beaverhead Forest Boundary were evaluated on August 17, 1976. The Upper East Dyce segment was rated as 'good' (46) (Table 6) and the Upper West Dyce segment as 'good' (71) (Table 7). The Lower East Dyce and Lower West Dyce stream segments were independently evaluated by Bureau personnel.

Precipitation

Precipitation was measured at the Upper West Dyce precipitation station from April 22 through November 12, 1977 and from April 18 until September 14, 1978. The general precipitation patterns during these two fiscal years

Table 6 R-1 STREAM CHANNEL STABILITY FIELD EVALUATION FORM

Upper East Dyce
8/17/76

Item Rated	Stability Indicators by Classes								
I. UPPER BANKS	EXCELLENT		GOOD		FAIR		POOR		
Landform Slope	Bank slope gradient <30%	②	Bank slope gradient 30-40%	(4)	Bank slope gradient 40-60%	(6)	Bank slope gradient 60% +	(8)	8
Mass Wasting (Existing or Potential)	No evidence of past or potential for future mass wasting into channels.	~~(3)~~ ②	Infrequent and/or very small. Mostly healed over. Low future potential.	(6)	Moderate frequency & size, with some raw spots eroded by water during high flows.	(9)	Frequent or large, causing sediment nearly yearlong OR imminent danger of same.	(12)	12
Debris Jam Potential (Floatable Objects)	Essentially absent from immediate channel area.	(2)	Present but mostly small twigs and limbs.	(4)	Present, volume and size are both increasing.	~~(6)~~ ⑤	Moderate to heavy amounts, predominantly larger sizes.	(8)	8
Bank Protection from Vegetation	90% + plant density. Vigor and variety suggests a deep, dense root mass.	(3) ②	70-90% density. Fewer plant species or lower vigor suggests a less dense or deep root mass.	(6)	50-70% density. Lower vigor and still fewer species form a somewhat shallow and discontinuous root mass.	(9)	<50% density plus fewer species & less vigor indicate poor, discontinuous, and shallow root mass.	(12)	12
II. LOWER BANKS									
Channel Capacity	Ample for present plus some increases. Peak flows contained. W/D ratio <7.	①	Adequate. Overbank flows rare. Width to Depth (W/D) ratio 8-15.	(2)	Barely contains present peaks. Occasional overbank floods. W/D ratio 15-25.	(3)	Inadequate. Overbank flows common. W/D ratio >25.	(4)	4
Bank Rock Content	65% + with large, angular boulders 12" + numerous.	(2)	40 to 65%, mostly small boulders to cobble 6-12".	(4)	20 to 40%, with most in the 3-6" diameter class.	⑥	<20% rock fragments of gravel sizes, 1-3" or less.	(8)	8
Obstructions Flow Deflectors Sediment Traps	Rocks, old logs firmly embedded. Flow pattern of pool & riffles stable without cutting or deposition.	②	Some present, causing erosive cross currents and minor pool filling. Obstructions and deflectors newer and less firm.	(4)	Moderately frequent, moderately unstable obstructions & deflectors move with high water causing bank cutting and filling of pools.	(6)	Frequent obstructions and deflectors cause bank erosion yearlong. Sed. traps full, channel migration occuring.	(8)	8
Cutting	Little or none evident. Infrequent raw banks less than 6" high generally.	~~(4)~~ ②	Some, intermittently at outcurves & constrictions. Raw banks may be up to 12".	(8)	Significant. Cuts 12"-24" high. Root mat overhangs and sloughing evident.	(12)	Almost continuous cuts, some over 24" high. Failure of overhangs frequent.	(16)	16
Deposition	Little or no enlargement of channel or point bars.	~~(4)~~ ③	Some new increas in bar formation, most from coarse gravels.	(8)	Moderate deposition of new gravel & coarse sand on old and some new bars.	(12)	Extensive deposits of predominately fine particles. Accelerated bar development.	(16)	16
III. BOTTOM									
Rock Angularity	Sharp edges and corners, plane surfaces roughened.	①	Rounded corners & edges, surfaces smooth & flat.	(2)	Corners & edges well rounded in two dimensions.	(3)	Well rounded in all dimensions, surfaces smooth.	(4)	4
Brightness	Surfaces dull, darkened, or stained. Gen. not "bright".	(1)	Mostly dull but may have up to 35% bright surfaces.	(2)	Mixture, 50-50% dull and bright, ± 15%, ie 35-65%.	(3)	Predominately bright, 65% + exposed or scoured surfaces.	④	
Consolidation or Particle Packing	Assorted sizes tightly packed and/or overlapping.	(2)	Moderately packed with some overlapping.	~~(4)~~ ③	Mostly a loose assortment with no apparent overlap.	(6)	No packing evident. Loose assortment, easily moved.	(8)	8
Bottom Size Distribution & Percent Stable Materials	No change in sizes evident. Stable materials 80-100%.	(4)	Distribution shift slight. Stable materials 50-80%.	~~(8)~~ ⑤	Moderate change in sizes. Stable materials 20-50%.	(12)	Marked distribution change. Stable materials 0-20%.	(16)	16
Scouring and Deposition	Less than 5% of the bottom affected by scouring and deposition.	(6)	5-30% affected. Scour at constrictions and where grades steepen. Some deposition in pools.	(12) ⑦	30-50% affected. Deposits & scour at obstructions, constrictions, and bends. Some filling of pools.	(18)	More than 50% of the bottom in a state of flux or change nearly yearlong.	(24)	24
Clinging Aquatic Vegetation (Moss & Algae)	Abundant. Growth largely moss like, dark green, perennial. In swift water too.	①	Common. Algal forms in low velocity & pool areas. Moss here too and swifter waters.	(2)	Present but spotty, mostly in backwater areas. Seasonal blooms make rocks slick.	(3)	Perennial types scarce or absent. Yellow-green, short term bloom may be present.	(4)	4
COLUMN TOTALS →	16		→ 15		→ 11		→ 4		

Add the values in each column for a total reach score here. (E. 16 + G. 15 + F. 11 + P. 4 = 46).

Reach score of: <38=Excellent, 39-76=Good, 77-114= Fair, 115+=Poor.

R1-2500-5 (6

USDA-FOREST SERVICE

Table 7 R-1 STREAM CHANNEL STABILITY FIELD EVALUATION FORM

Upper West Dyce
8/17/76

Item Rated	Stability Indicators by Classes							
	EXCELLENT		GOOD		FAIR		POOR	
I. UPPER BANKS								
Landform Slope	Bank slope gradient <30%	[✓ (2)]	Bank slope gradient 30-40%	(4)	Bank slope gradient 40-60%	(6)	Bank slope gradient 60% +	8
Mass Wasting (Existing or Potential)	No evidence of past or potential for future mass wasting into channels.	[✓ (3)]	Infrequent and/or very small, Mostly healed over. Low future potential.	(6)	Moderate frequency & size, with some raw spots eroded by water during high flows.	(9)	Frequent or large, causing sediment nearly yearlong OR imminent danger of same.	12
Debris Jam Potential (Floatable Objects)	Essentially absent from immediate channel area.	(2)	Present but mostly small twigs and limbs.	(4)	Present, volume and size are both increasing.	(6) [✓ 5]	Moderate to heavy amounts, predominantly larger sizes.	8
Bank Protection from Vegetation	90% + plant density. Vigor and variety suggests a deep, dense root mass.	(3)	70-90% density. Fewer plant species or lower vigor suggests a less dense or deep root mass.	[✓ (6)]	50-70% density. Lower vigor and still fewer species form a somewhat shallow and discontinuous root mass.	(9)	<50% density plus fewer species & less vigor indicate poor, discontinuous, and shallow root mass.	12
II. LOWER BANKS								
Channel Capacity	Ample for present plus some increases. Peak flows contained. W/D ratio <7.	(1)	Adequate. Overbank flows rare. Width to Depth (W/D) ratio 8-15.	(2)	Barely contains present peaks. Occasional overbank floods. W/D ratio 15-25.	[✓ (3)]	Inadequate. Overbank flows common. W/D ratio >25.	4
Bank Rock Content	65% + with large, angular boulders 12" + numerous.	(2)	40 to 65%, mostly small boulders to cobble 6-12".	[✓ (4)]	20 to 40%, with most in the 3-6" diameter class.	(6)	<20% rock fragments of gravel sizes, 1-3" or less.	8
Obstructions Flow Deflectors Sediment Traps	Rocks, old logs firmly embedded. Flow pattern of pool & riffles stable without cutting or deposition.	(2)	Some present, causing erosive cross currents and minor pool filling. Obstructions and deflectors newer and less firm.	(4) [✓ 3]	Moderately frequent, moderately unstable obstructions & deflectors move with high water causing bank cutting and filling of pools.	(6)	Frequent obstructions and deflectors cause bank erosion yearlong. Sed. traps full, channel migration occuring.	8
Cutting	Little or none evident. Infrequent raw banks less than 6" high generally.	(4)	Some, intermittently at outcurves & constrictions. Raw banks may be up to 12".	(8) [✓ 6]	Significant. Cuts 12"-24" high. Root mat overhangs and sloughing evident.	(12)	Almost continuous cuts, some over 24" high. Failure of overhangs frequent.	16
Deposition	Little or no enlargement of channel or point bars.	(4)	Some new increas in bar formation, most from coarse gravels.	[✓ (8)]	Moderate deposition of new gravel & coarse sand on old and some new bars.	(12)	Extensive deposits of predominately fine particles. Accelerated bar development.	16
III. BOTTOM								
Rock Angularity	Sharp edges and corners, plane surfaces roughened.	(1)	Rounded corners & edges, surfaces smooth & flat.	[✓ (2)]	Corners & edges well rounded in two dimensions.	(3)	Well rounded in all dimensions, surfaces smooth.	4
Brightness	Surfaces dull, darkened, or stained. Gen. not "bright".	(1)	Mostly dull but may have up to 35% bright surfaces.	(2)	Mixture, 50-50% dull and bright, ± 15%, ie 35-65%.	[✓ (3)]	Predominately bright, 65% +, exposed or scoured surfaces.	4
Consolidation or Particle Packing	Assorted sizes tightly packed and/or overlapping.	(2)	Moderately packed with some overlapping.	(4)	Mostly a loose assortment with no apparent overlap.	(6) [✓ 5]	No packing evident. Loose assortment, easily moved.	8
Bottom Size Distribution & Percent Stable Materials	No change in sizes evident. Stable materials 80-100%.	(4)	Distribution shift slight. Stable materials 50-80%.	[✓ (8)]	Moderate change in sizes. Stable materials 20-50%.	(12)	Marked distribution change. Stable materials 0-20%.	16
Scouring and Deposition	Less than 5% of the bottom affected by scouring and deposition.	(6)	5-30% affected. Scour at constrictions and where grades steepen. Some deposition in pools.	(12) [✓ 10]	30-50% affected. Deposits & scour at obstructions, constrictions, and bends. Some filling of pools.	(18)	More than 50% of the bottom in a state of flux or change nearly yearlong.	24
Clinging Aquatic Vegetation (Moss & Algae)	Abundant. Growth largely moss like, dark green, perennial. In swift water too.	(1)	Common. Algal forms in low velocity & pool areas. Moss here too and swifter waters.	(2)	Present but spotty, mostly in backwater areas. Seasonal blooms make rocks slick.	[✓ (3)]	Perennial types scarce or absent. Yellow-green, short term bloom may be present.	4
COLUMN TOTALS →		5	→	47	→	19	→	–

Add the values in each column for a total reach score here. (E. 5 + G. 47 + F. 19 + P. – = 71).

Reach score of: <38=Excellent, 39-76=Good, 77-114= Fair, 115+=Poor.

are compared to those of the Dillon and Lima weather stations (Figure 34). The Upper West Dyce station precipitation pattern approximates that of the Lima station for the two field seasons. While 1977 exhibited May and July precipitation peaks, the latter was absent for 1978.

Stream Discharge

The staff-discharge rating curves for Lower and Upper East Dyce, and Lower and Upper West Dyce are presented in Figures 35-38. The Lower East Dyce gauging site remained stable during the sampling period, except for some moderate algal growth during the latter months of 1978. The Upper East Dyce site remained relatively stable, as did the Lower West Dyce station after it was moved. The Upper West Dyce channel site was not stable.

The 1977 and 1978 annual hydrographs for the East and West Dyce sampling stations are presented in Figure 39-46. An early peak flow of 4.1 cfs occurred in early to mid-April, 1977 at the Lower East Dyce station during an unusually warm period, although a higher flow may have passed prior to the first sampling. A second peak of 4.4 cfs is indicated for mid-June. The lowest flow was recorded at 0.96 cfs for mid-July. During the wetter 1978 year, an early peak of 3.8 cfs in early April was followed by a monitored peak of 9.1 cfs in late May. Low flow for the year was 1.0 cfs in previous October. The Upper East Dyce station data indicate an early peak of 3.6 cfs in early May, 1977 although a higher flow may have occurred earlier. The annual peak apparently passed in mid-June, estimated at 5.1 cfs. Lowest flow for the year was 0.78 during late September. The annual peak discharge for 1978 at the Upper East Dyce station apparently passed in early June at an estimated 6.2 cfs, while the year's lowest flow of 0.60 cfs was recorded the previous October.

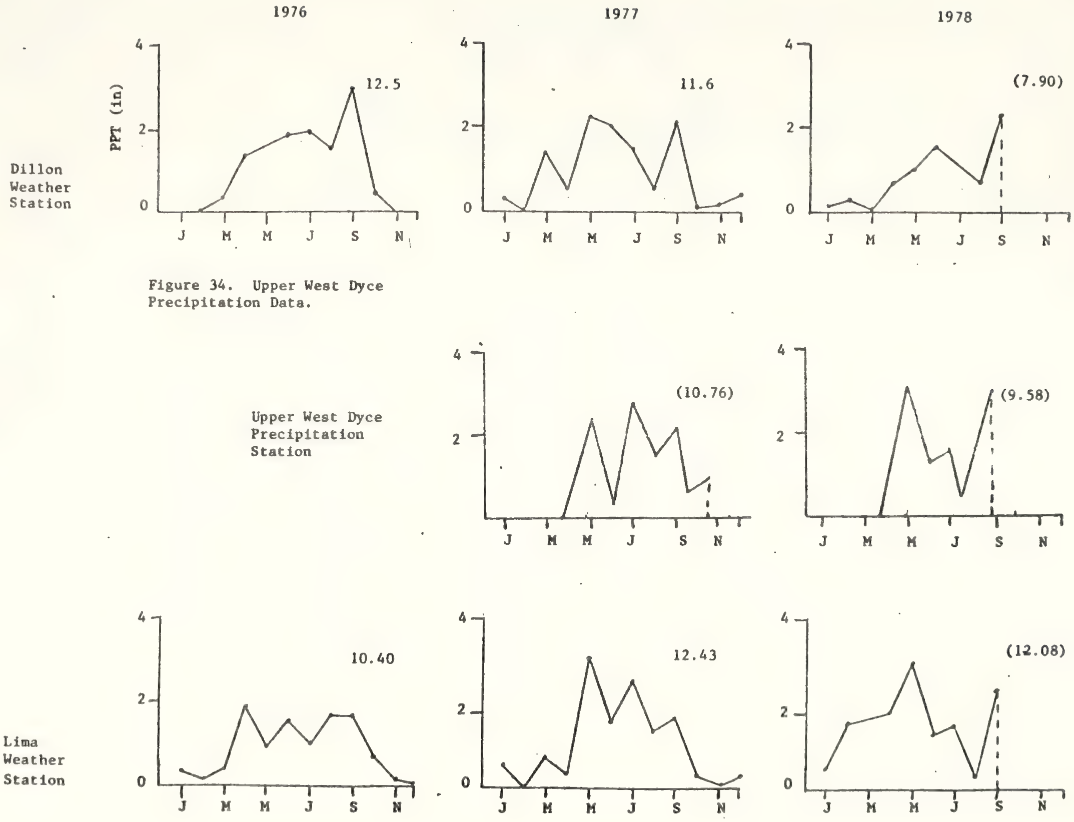


Figure 34. Upper West Dyce Precipitation Data.

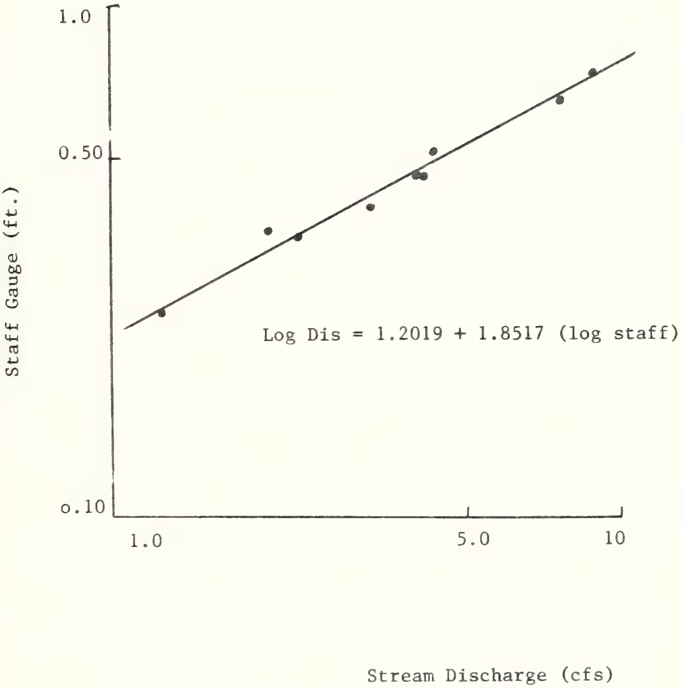


Figure 35. Staff-discharge Rating Curve for the Lower East Dyce Station.

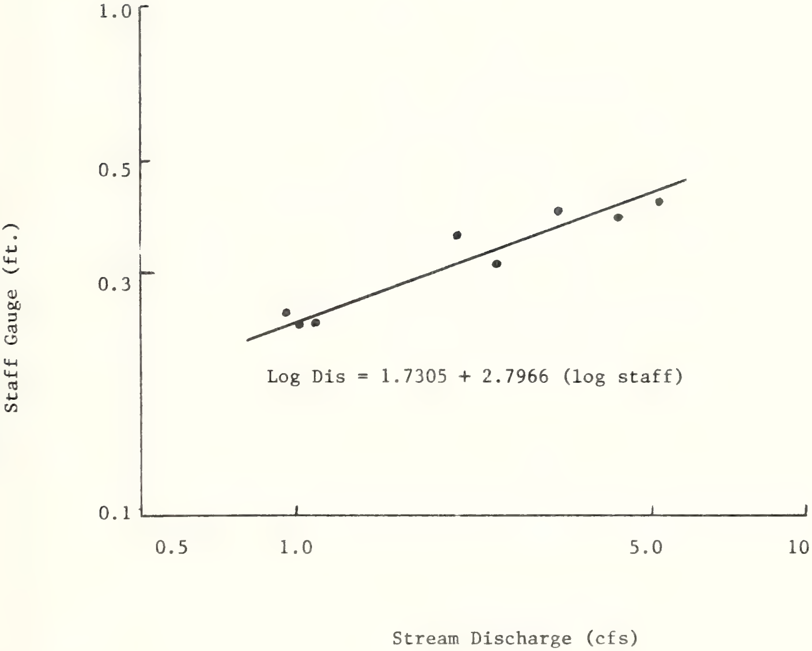
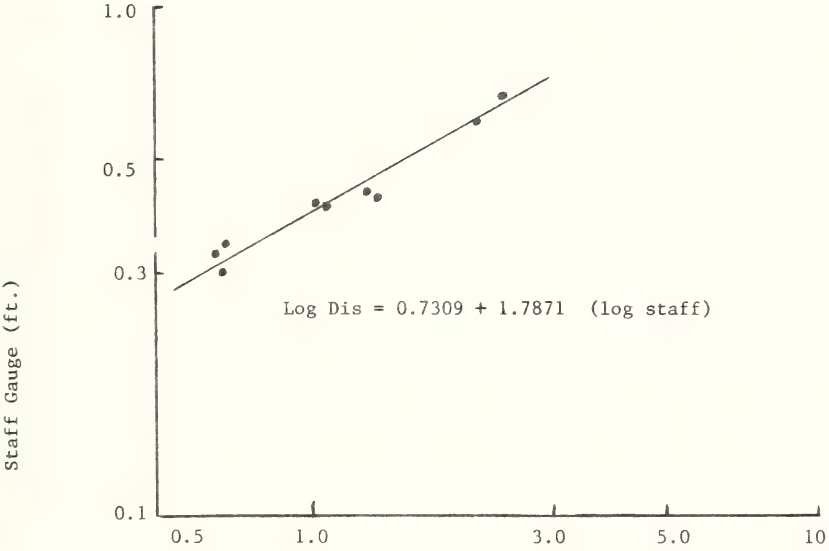


Figure 36. Staff-discharge Rating Curve for the Upper East Dyce Station.



Stream Discharge (cfs)

Figure 37. Staff-discharge Rating Curve for the Lower West Dyce Station.

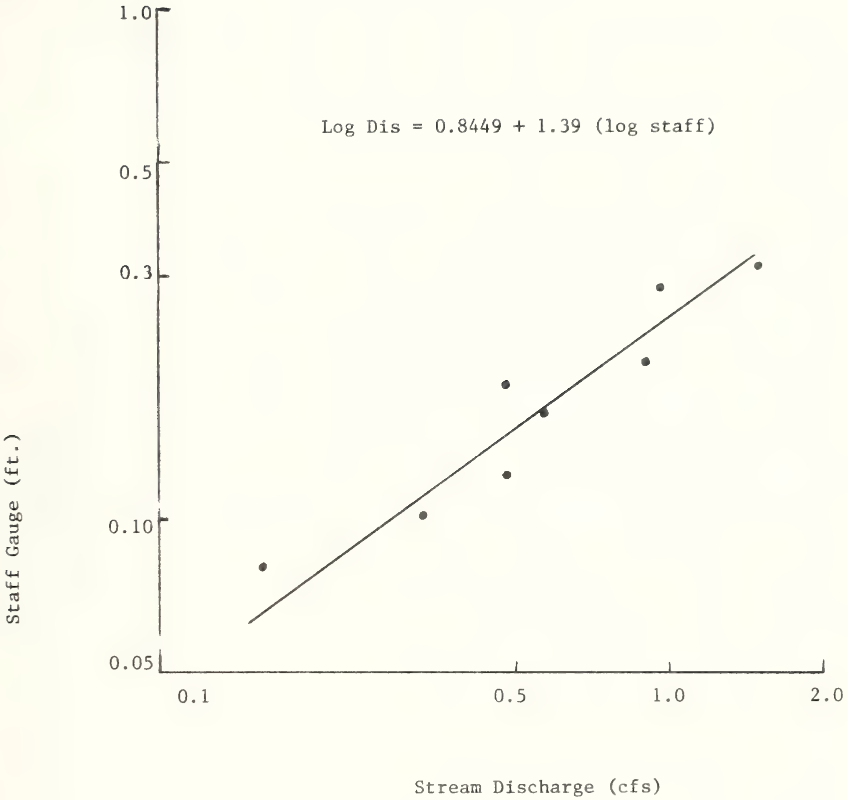


Figure 38. Staff-discharge Rating Curve for the Upper West Dyce Station.

FIGURE 39. ANNUAL HYDROGRAPH AND SEDIMENT LOADINGS

LOWER EAST DYCE - 1977

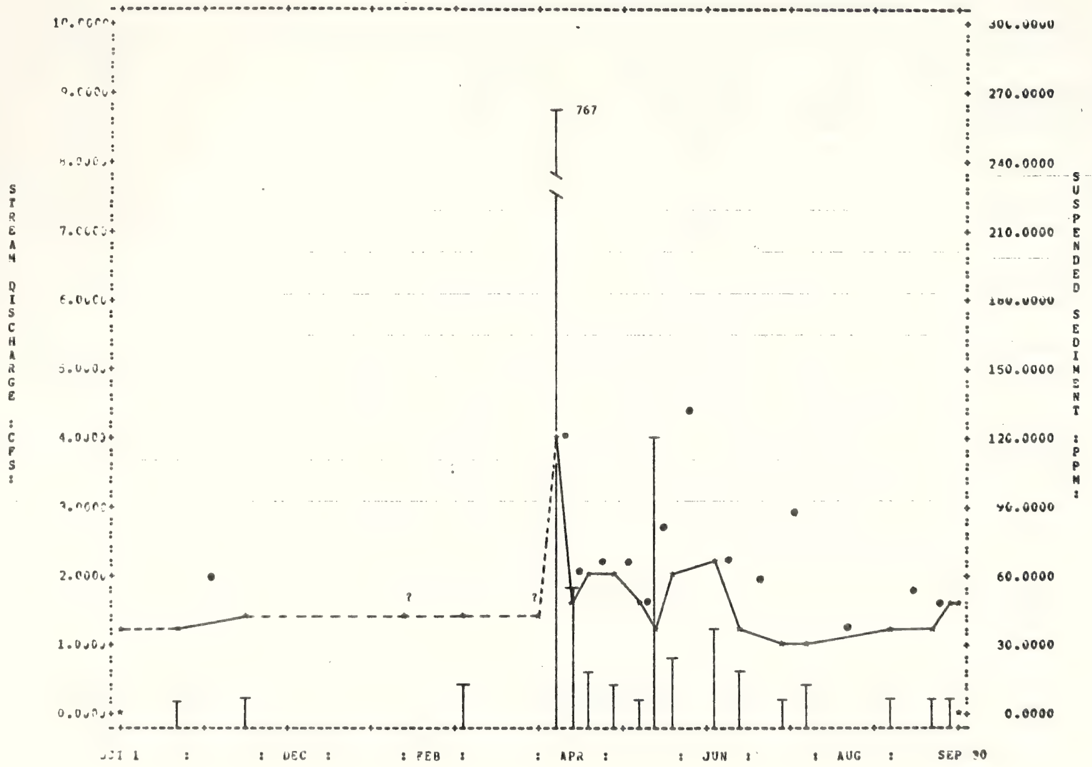


FIGURE 40. ANNUAL HYDROGRAPH AND SEDIMENT LOADINGS

LOWER EAST DYCE - 1978

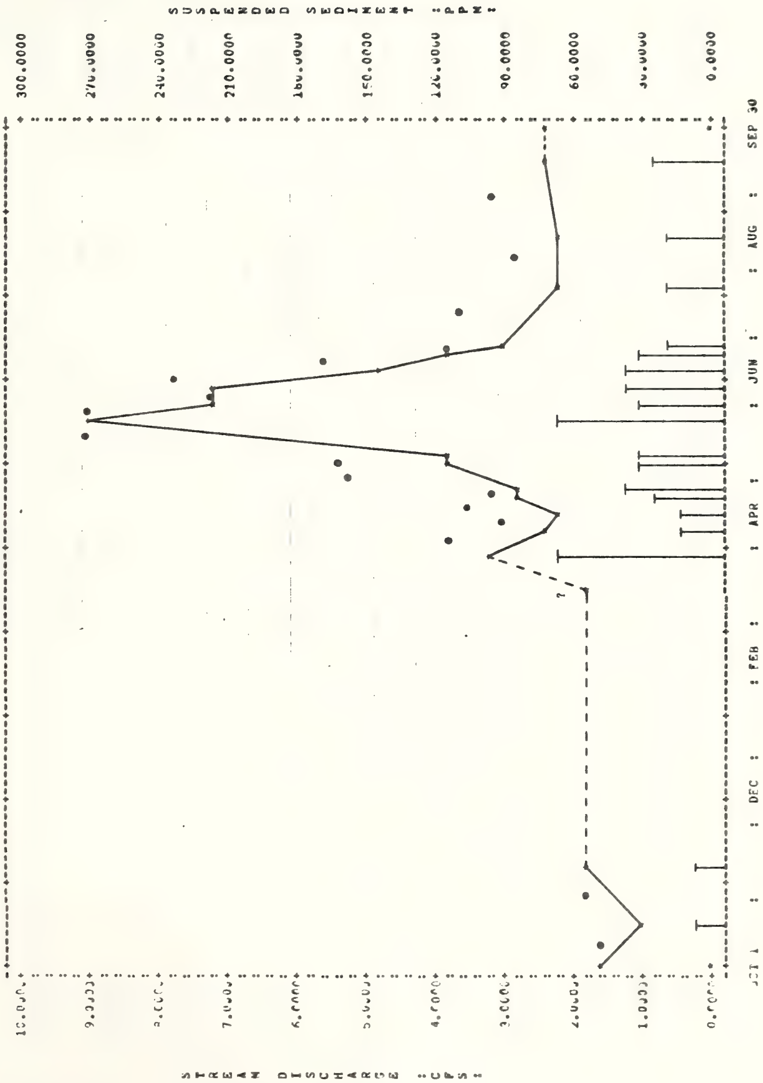


FIGURE 41. ANNUAL HYDROGRAPH AND SEDIMENT LOADINGS

UPPER EAST DYCE - 1977

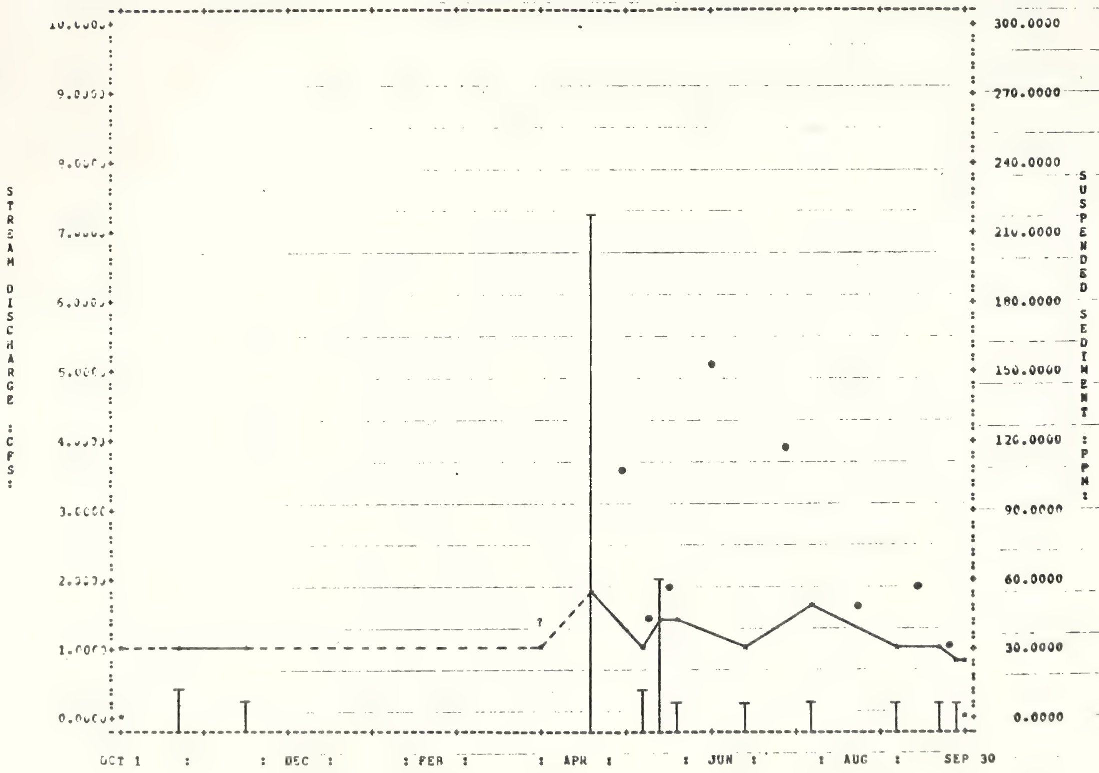


FIGURE 42. ANNUAL HYDROGRAPH AND SEDIMENT LOADINGS

UPPER EAST DYCE - 1978

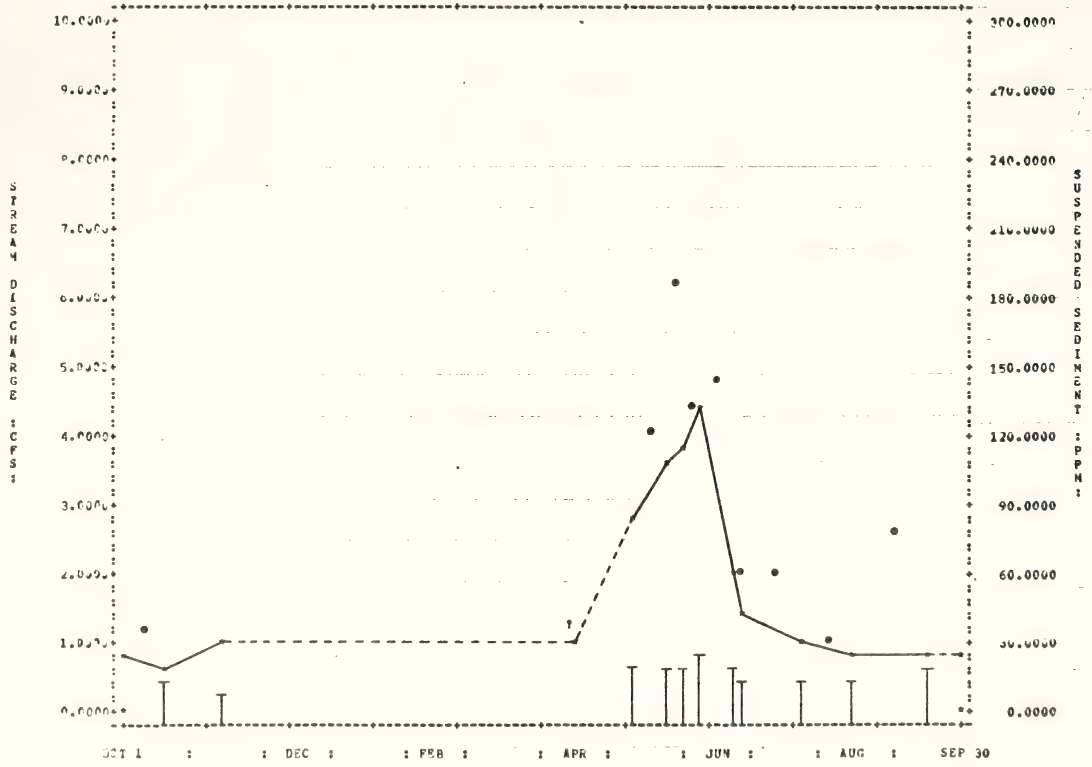


FIGURE 43. ANNUAL HYDROGRAPH AND SEDIMENT LOADINGS

LOWER WEST DYCE - 1977

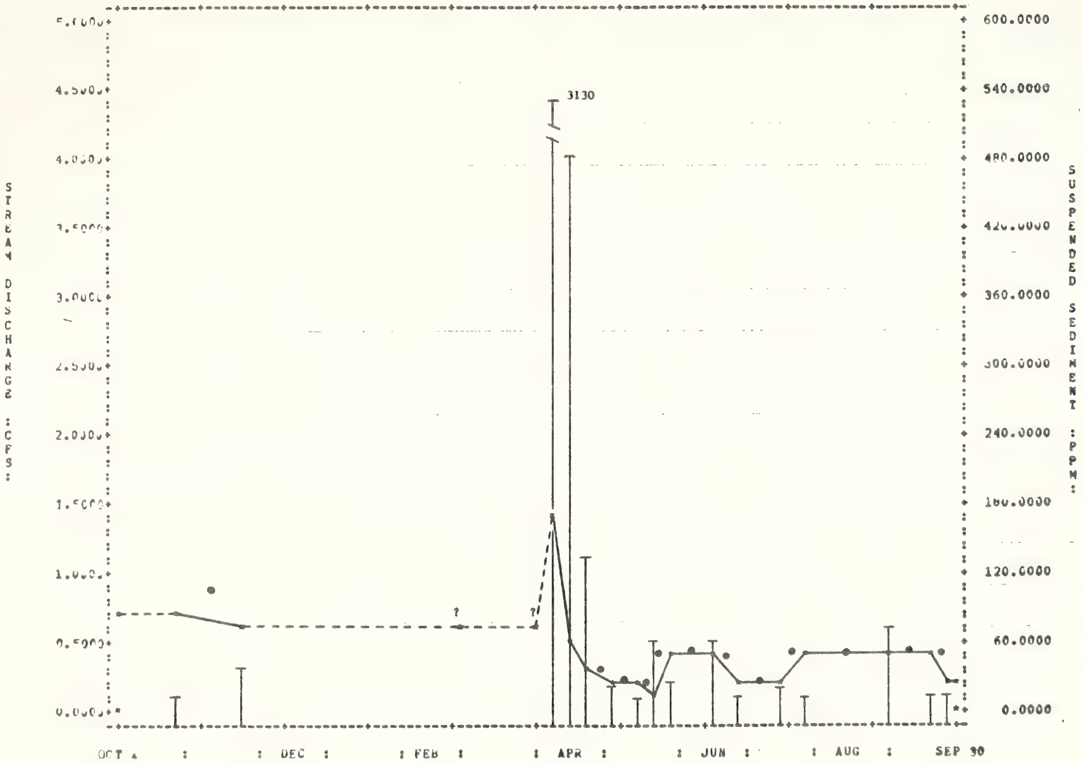


FIGURE 44. ANNUAL HYDROGRAPH AND SEDIMENT LOADINGS

LOWER WEST DYCE - 1978

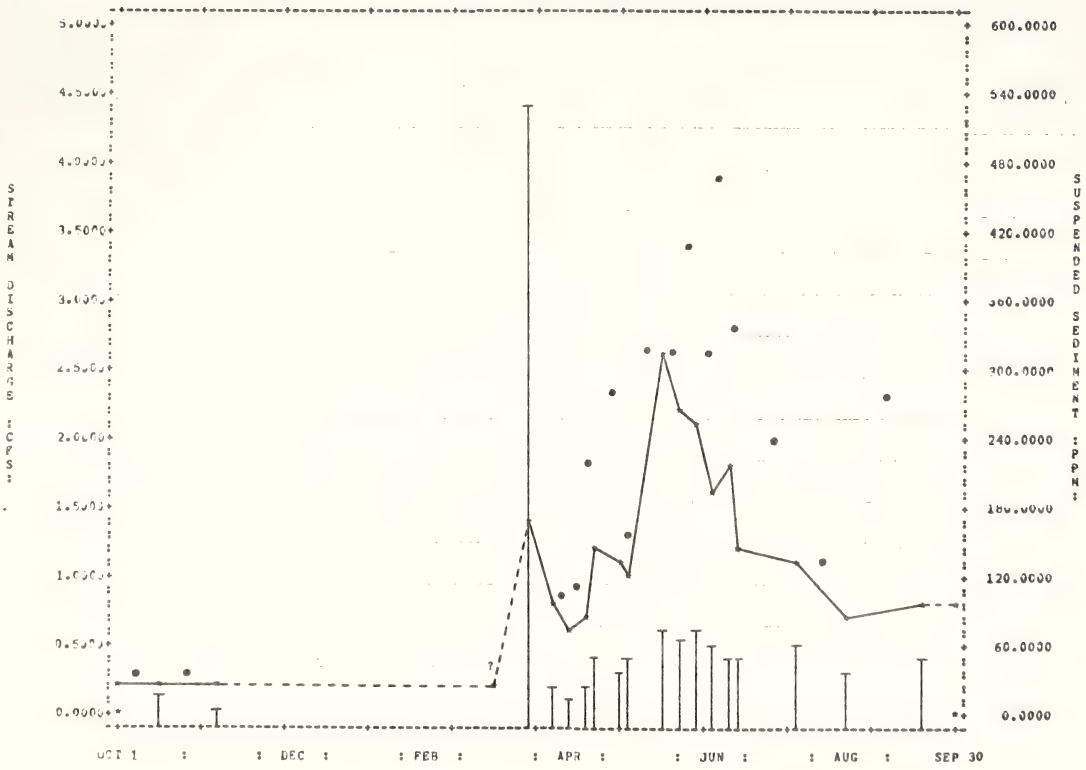


FIGURE 45. ANNUAL HYDROGRAPH AND SEDIMENT LOADINGS

UPPER WEST DYCE - 1977

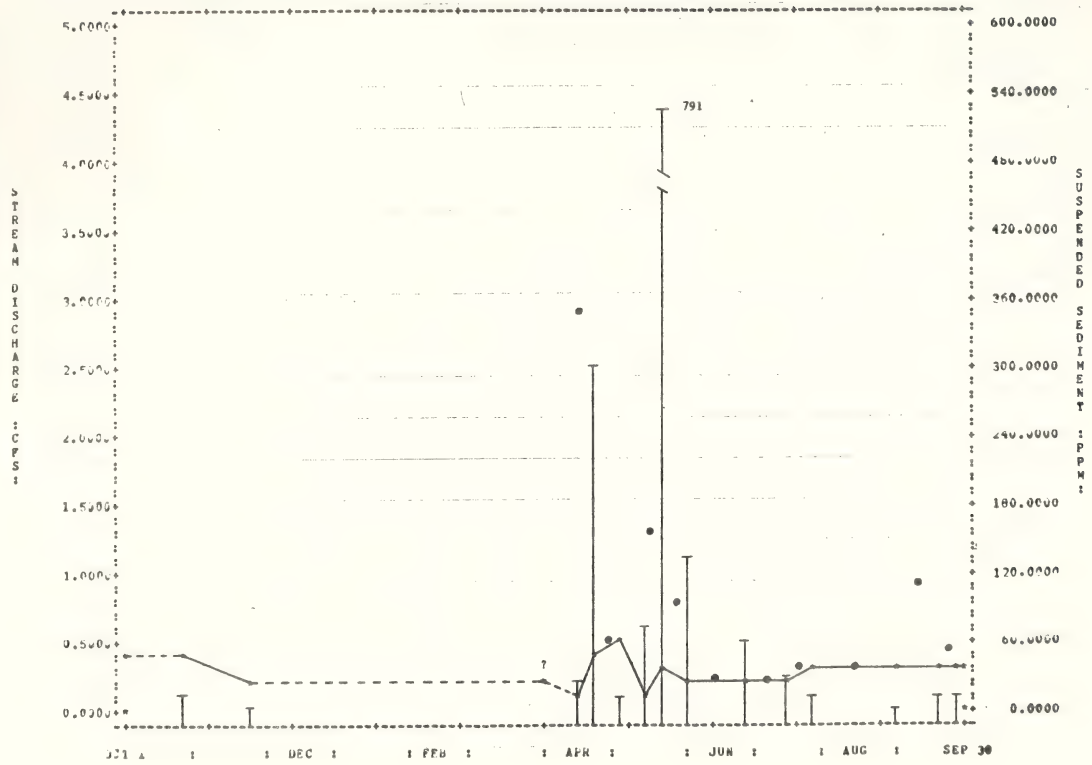
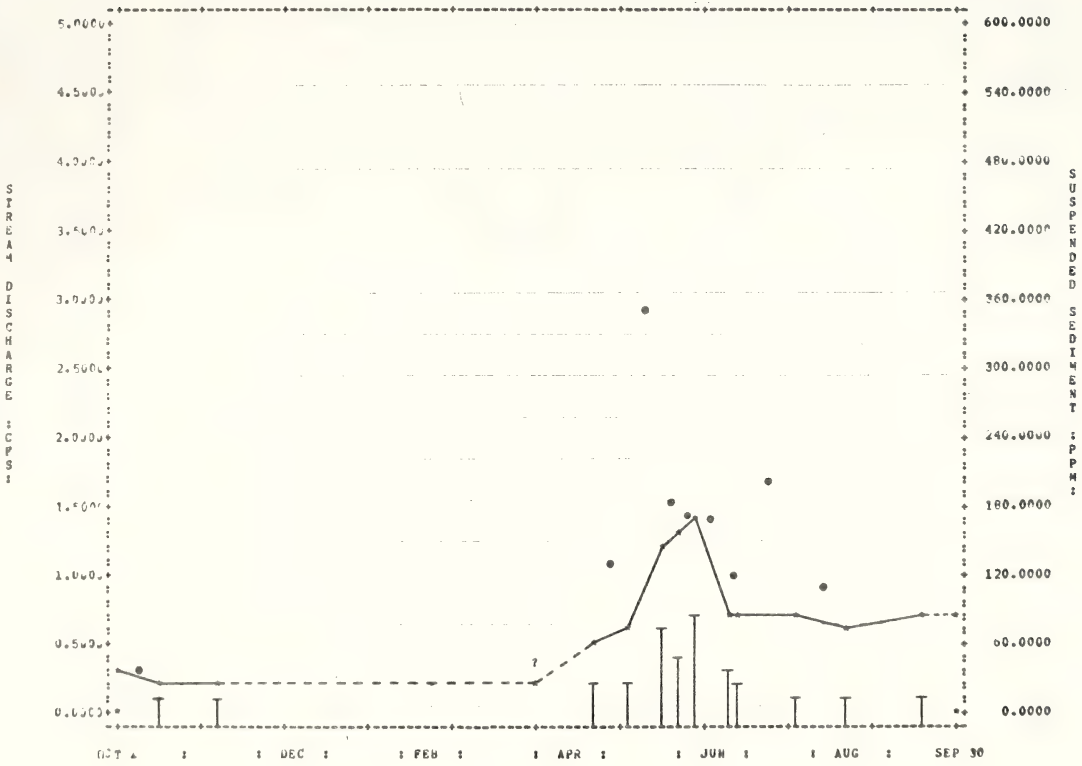


FIGURE 46. ANNUAL HYDROGRAPH AND SEDIMENT LOADINGS

UPPER WEST DYCE - 1978



Flow patterns for the Lower West Dyce sampling station for the 1977 hydrologic year are underestimated owing to an unfavorable gauging site. An early peak of 1.4 cfs over the ice was monitored in early April. The residual channel ice remained for several weeks. A secondary peak was not recorded. Low flow for the year was approximately 0.15 cfs in late May. During 1978, however, the new station recorded an annual peak of 3.9 cfs in mid-June, while the low flow of 0.20 cfs occurred the previous October. The Upper West Dyce sampling station recorded an estimated peak flow of 2.9 cfs in mid-April 1977, while low flow for the year was 0.11 cfs in mid-May. During 1978, peak flow again was estimated at 2.9 cfs, but in mid-May. The previous November recorded the lowest flow at 0.18 cfs. The differences noted in flow patterns for the two hydrologic years are largely attributed to differences in the annual precipitation and snow melt patterns.

The respective annual hydrograph data were used to estimate the annual water yields for each station (Table 8). The lower East Dyce station had the greatest estimated annual water yields at 1,080 acre feet and 1,920 acre feet respectively. Yields at the Upper East Dyce station increased marginally, 836 acre feet to 956 acre feet, a condition that may be partially attributable to the timing of the sampling. The Lower West Dyce station had estimated water yields of 357 acre feet and 525 acre feet. The lowest water yields were for the small Upper West Dyce watershed, 192 acre feet and 332 acre feet respectively.

Suspended Sediment

The annual patterns of sediment concentrations for each station by hydrologic year are depicted in Figures 39-46. Suspended sediment concentrations at the Lower East Dyce station ranged from $<$ 5 ppm at low flow to a high of 776 ppm flow, while those for the Upper East Dyce station

Table 8. Estimated Water and Sediment Yields for Dyce Creek, 1977 - 1978.

Station Name	Water Year	Estimated Water Yield	Estimated Sediment Yield (tons)	Contributing Watershed (acres)	Runoff (in./ac.)	Sediment Yield (lbs/acre)
Lower East Dyce Station	1977	1,080	79	3,710	3.49	43
	1978	1,920	66	3,710	6.21	36
Upper East Dyce Station	1977	836	32	990	10.1	65
	1978	956	17	990	11.6	34
Lower West Dyce Station	1977	357	102	2,050	2.09	100
	1978	525	54	2,050	3.07	53
Upper West Dyce Station	1977	192	12	450	5.12	53
	1978	332	11	450	8.85	49

ranged from $<$ 5 ppm to 216 ppm. The Lower West Dyce station's sediment concentrations ranged from $<$ 5 ppm to a high of 3,130 ppm, while those at the Upper West Dyce station extended from 6 ppm to 303 ppm. Higher suspended sediment values were recorded during the 1978 hydrologic year when there were higher discharge values. The relationships between suspended sediment and stream discharge for the Lower East and Lower West Dyce stations were statistically significant, however, the relationships were not significant for the Upper stations (Figures 47-50). The variability in sediment concentration with stream flow is partially attributed to a seasonal effect, specific storm effect, and to the hysteresis effect, whereby peak concentrations of suspended sediment generally occur prior to peak runoff during the rising stage (Gregory and Walling, 1973, pp. 215-219). Annual sediment yields for the four sampling stations were estimated from respective water yield and sediment concentration data (Table 8). The Lower and Upper East Dyce data indicated that approximately 79 tons and 32 tons of suspended sediment were produced respectively during 1977. These yields decreased to 66 tons and 17 tons for the more active 1978 hydrologic year. A similar pattern was observed for the West Dyce stations where 102 tons and 12 tons were generated in 1977. But only 54 tons and 11 tons were estimated for 1978. Although water yields were greater for 1978, the higher sediment concentration values in 1977 produced greater sediment yield values from each respective data set.

Hydrochemical Parameters

The concentration of dissolved solids is inversely related to stream discharge so that lower concentrations occur during periods of high runoff, while higher concentrations are found during periods of low summer base flow (Gunnerson, 1967; Gregory and Walling, 1973, pp. 219-225). Patterns for

FIGURE 47. SUSPENDED SEDIMENT VS STREAM DISCHARGE - LOWER EAST DYCE

LOG SED = 0.9526 + 1.0069(LOG DIS)

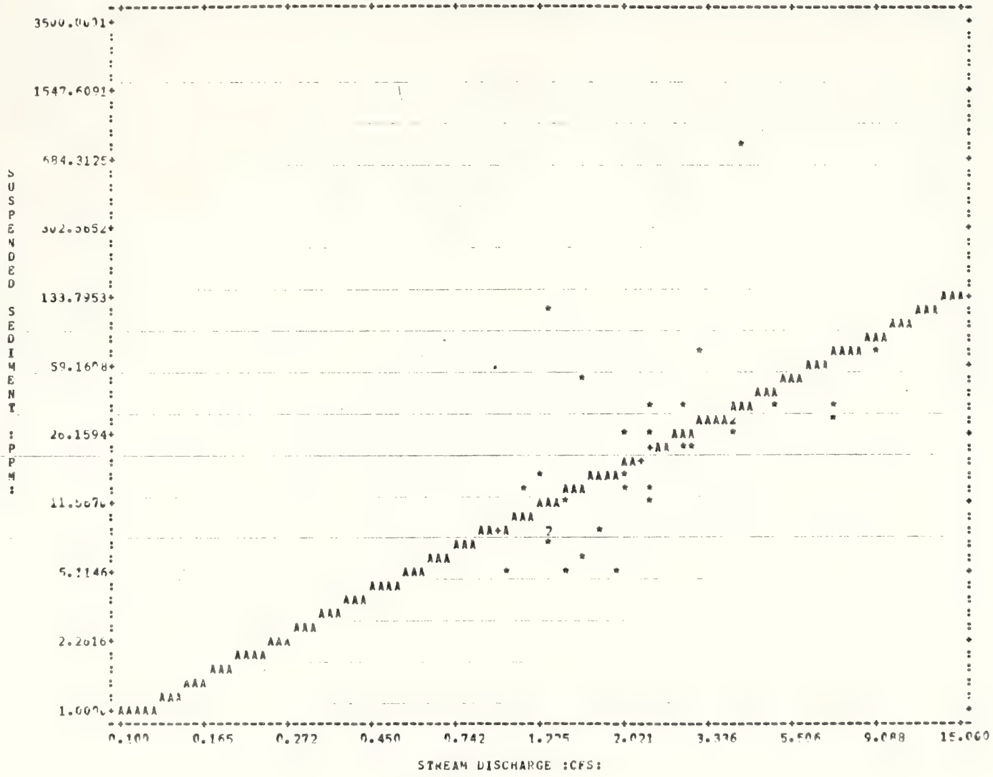


FIGURE 48. SUSPENDED SEDIMENT VS STREAM DISCHARGE - UPPER EAST DYCE

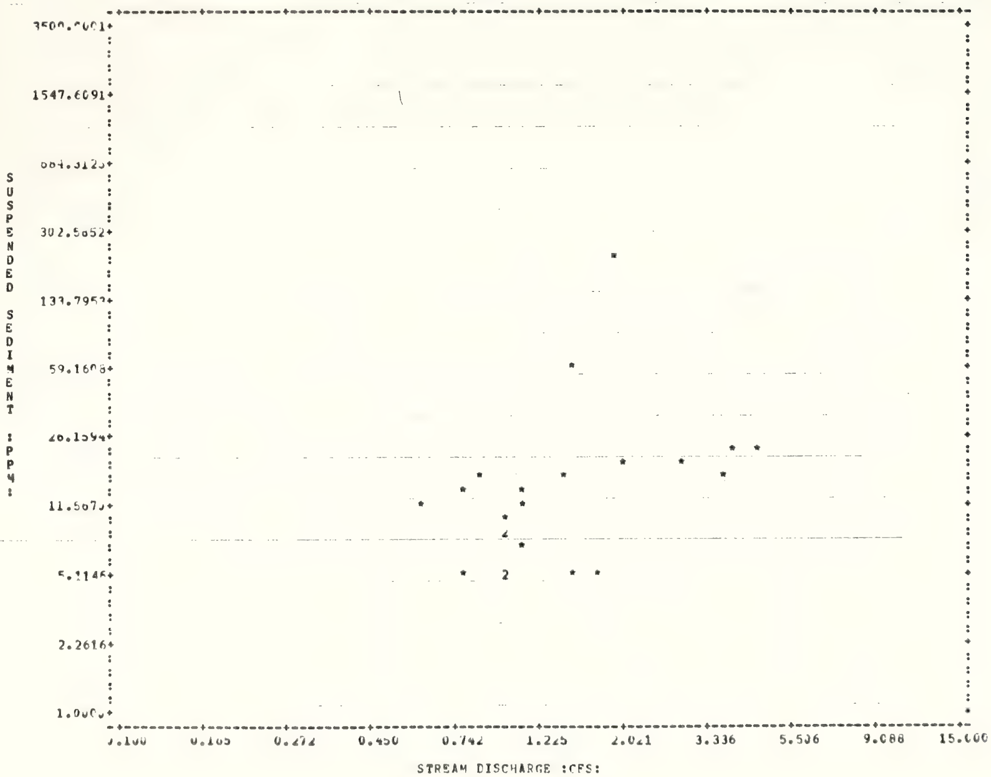


FIGURE 49. SUSPENDED SEDIMENT VS STREAM DISCHARGE - LOWER WEST DYCE

LOG SED = 1.7778 + 0.7511(LOG DIS)

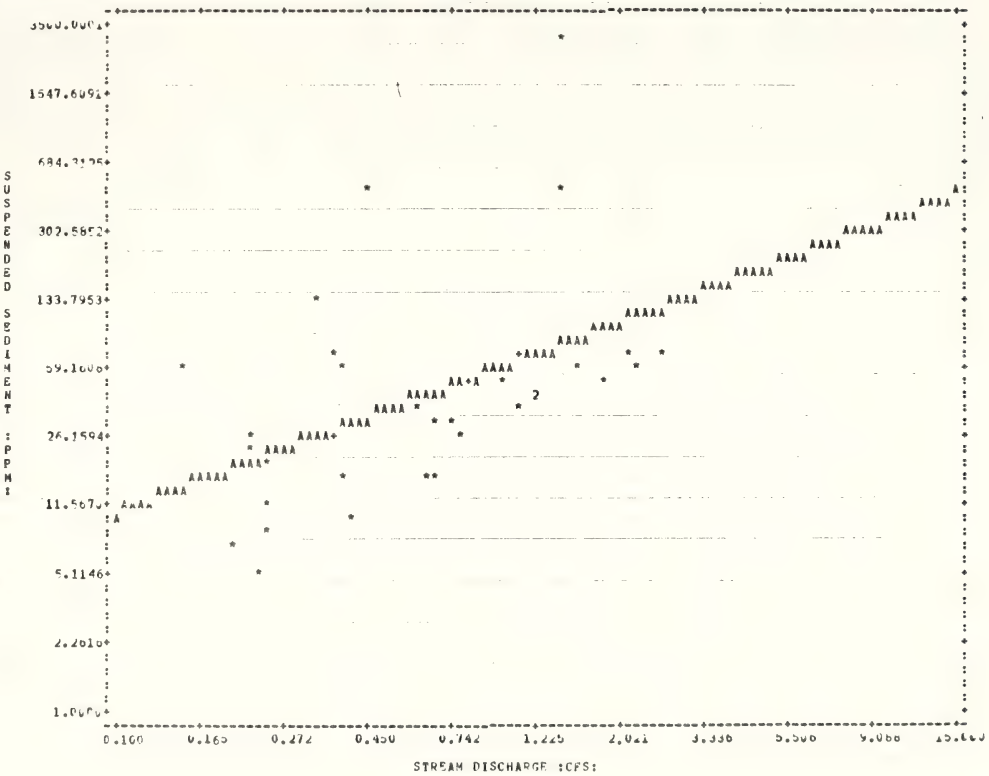
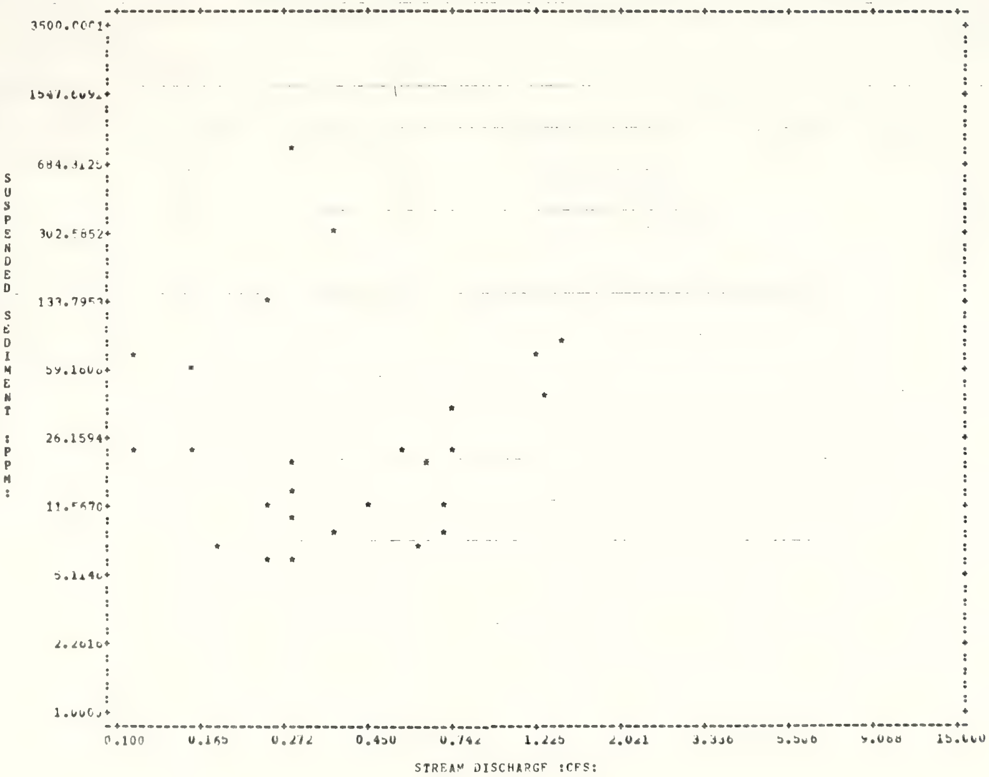


FIGURE 50. SUSPENDED SEDIMENT VS STREAM DISCHARGE - UPPER WEST DYCE



specific ions, especially the ecologically important ones, often vary from this generalization (Likens, et al., 1977, pp. 74-76).

Specific conductance for the Lower East Dyce station ranged from a low of 76 µmhos during high spring runoff to a high of 161 µmhos during low flow. The Upper East Dyce station exhibited a similar but less consistant pattern, with values ranging from 20 µmhos to a high of 72 µmhos. Conductivity at the Lower West Dyce station ranged from 187 µmhos to 345 µmhos, while those of Upper West Dyce extended from 128 µmhos to 190 µmhos. The relationships between specific conductance and stream discharge for each station were statistically significant and are presented in Figures 51-54. Variation in specific conductance with stream discharge is partially attributed to seasonal and storm hysteresis effects (Gregory and Walling, 1973, pp. 219-225). The ranges in ionic concentration for specific ions are presented in Table 9.

Bacteria Levels

The concentration of fecal and total coliform in streams draining rangeland watersheds is directly related to the number of cattle present, their access to the stream, the physical and hydrological characteristics of the basin, local weather conditions (Kunkle, 1970; Stephensen and Street, 1978), and the time of day (Kunkle and Meiman, 1968). Seasonal patterns include a spring "flushing" effect during the rising stage (Kunkle and Meiman, 1968), with high counts during the low flow summer period, counts which often continue for some period after the cattle have been removed from the area (Stephensen and Street, 1978). This seasonal pattern may briefly be modified by local storms which produce their own "flushing" effect, and which may or may not be followed by a short term dilution period.

FIGURE 51. CONDUCTIVITY VS STREAM DISCHARGE - LOWER EAST DYCE

LOG COND = 2.2047 - 0.2736(LOG DIS)

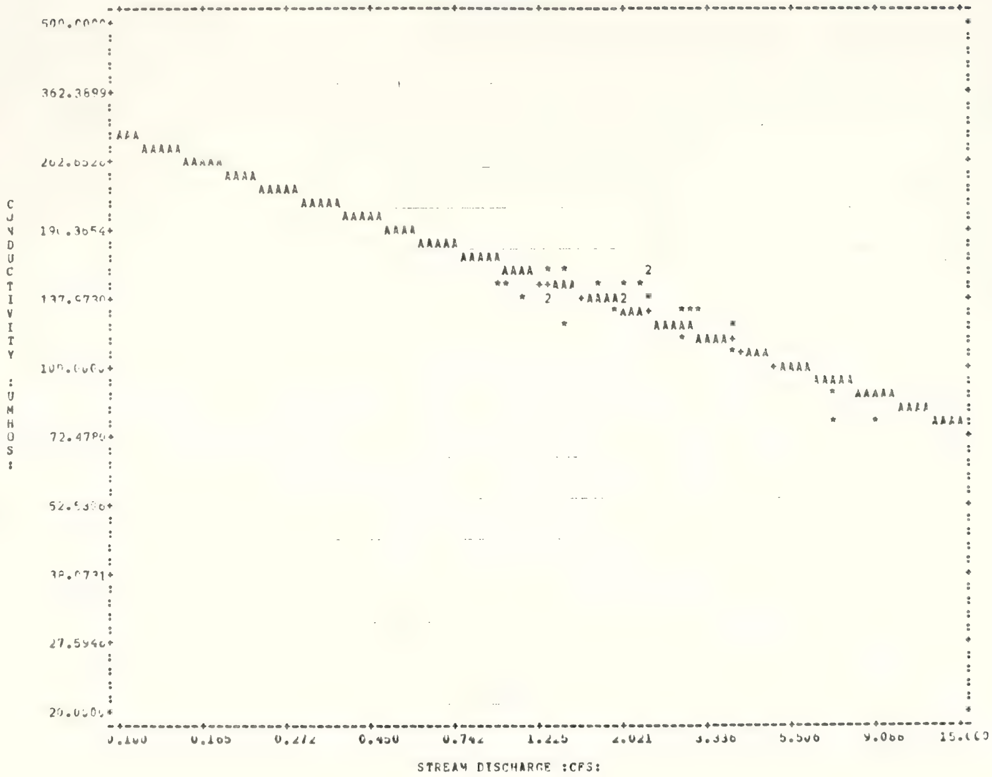


FIGURE 52. CONDUCTIVITY VS STREAM DISCHARGE - UPPER EAST DYCE

LOG COND = 1.6557 - 0.2760(LOG DIS)

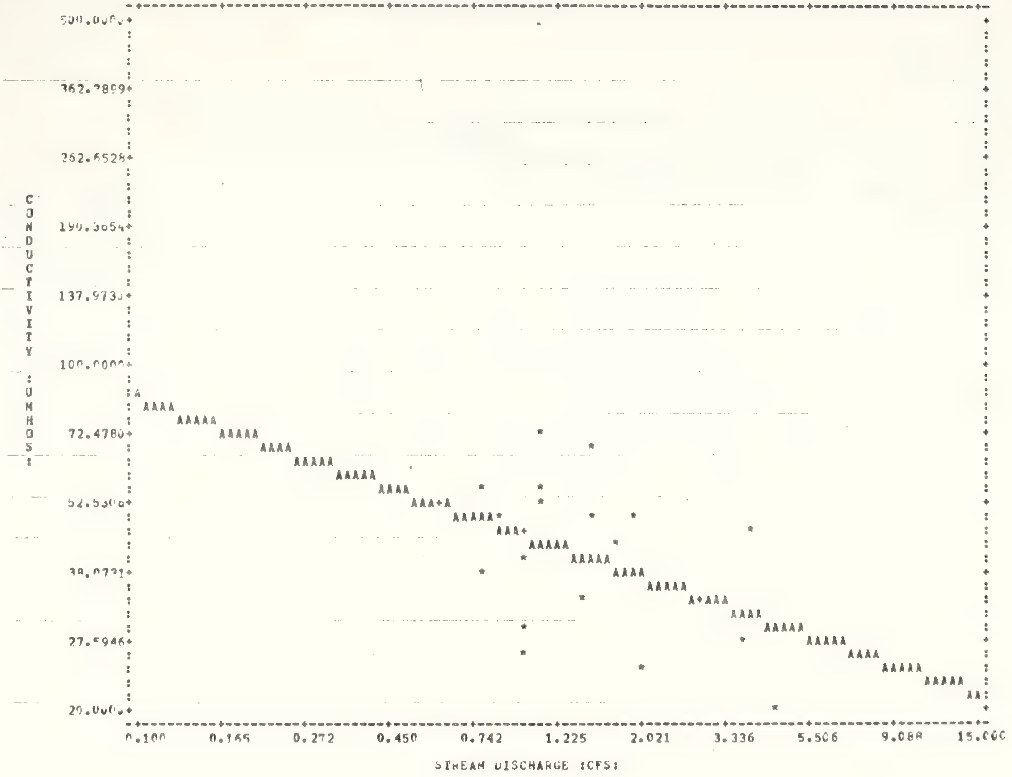


FIGURE 53. CONDUCTIVITY VS STREAM DISCHARGE - LOWER WEST DYCE

LOG COND = 2.4322 - 0.1041(LOG DIS)

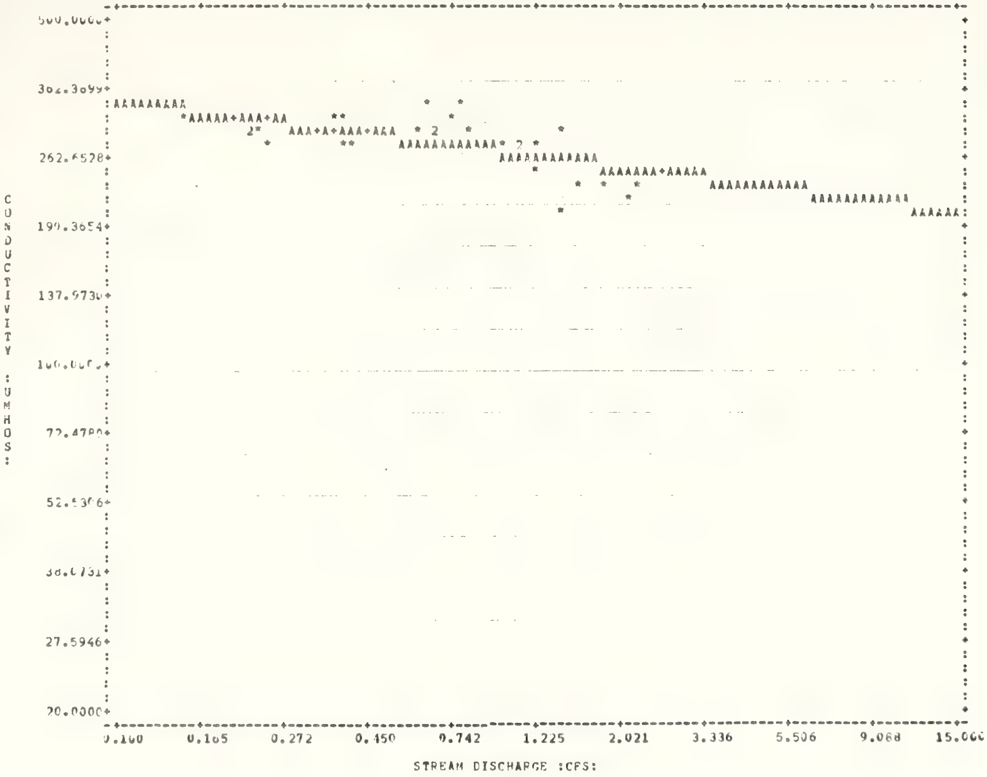


FIGURE 54. CONDUCTIVITY VS STREAM DISCHARGE - UPPER WEST DYCE

LOG COND = 2.1705 - 0.0825(LOG DIS)

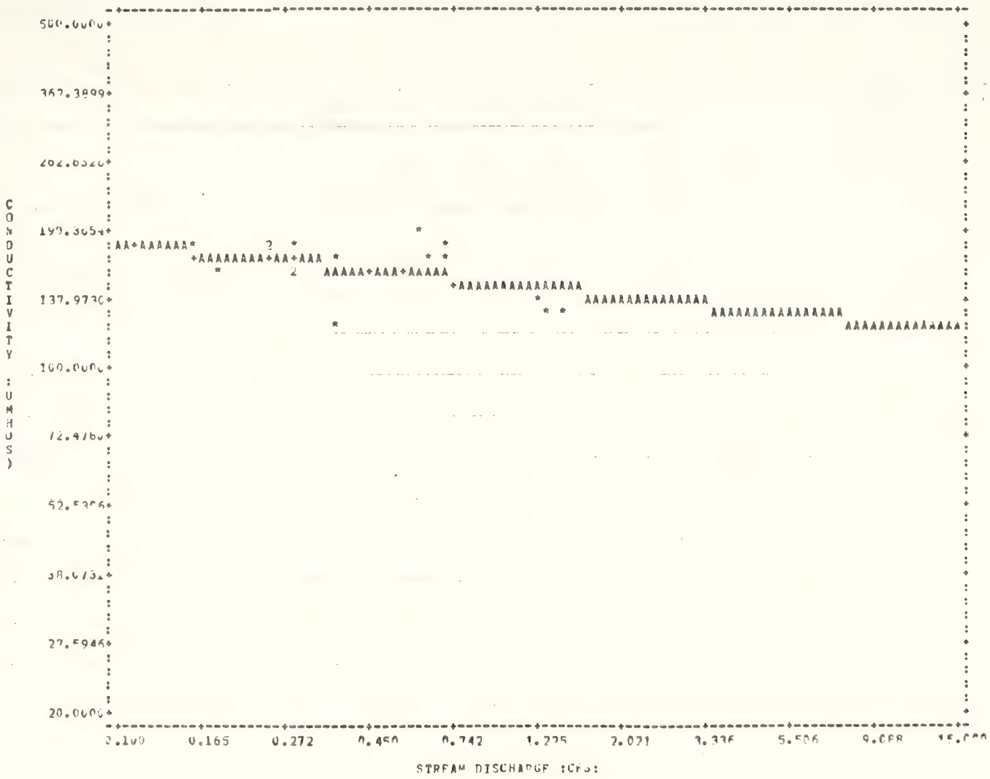


Table 9. Ranges of Hydrochemical Parameters for Dyce Creek, 1977 - 1978.

	Lower East Dyce	Upper East Dyce	Lower West Dyce	Upper West Dyce
pH	6.63 - 7.95	6.10 - 7.63	7.55 - 8.13	7.15 - 8.13
Alkalinity ($CaCO_3$) (mg/1)	41 - 81	10 - (88)	133 - 173	75 - 157
Specific Conductance (μmhos)	76 - 161	20 - 72	187 - 345	128 - 190
Total Dissolved Solids (mg/1)	49 - 105	13 - 47	122 - 224	83 - 124
Ca (mg/1)	9.8 - 23	3.1 - 7.3	30 - 48	20 - 32
Mg (mg/1)	3.3 - 8.7	.84 - 4.0	12 - 20	4.1 - 7.1
Na (mg/1)	1.5 - 3.0	.80 - 1.9	3.6 - 6.0	3.0 - 5.4
K (mg/1)	.92 - 2.0	.49 - 1.0	1.1 - 3.0	.89 - 1.7
HCO_3 (mg/1)	50 - 99	12 - (107)	160 - 211	90 - 192
SO_4 (mg/1)	2 - 4	1 - 5	1 - 8	3 - 6
NH_4 (mg/1)	$<$.01 - (.32)	$<$.01 - (.14)	$<$.01 - .17	$<$.01 - .08
NO_2 $+NO_3$ - N (mg/1)	.01 - .36	$<$.01 - .14	.01 - .48	$<$.01 - .29
PO_4 (Ortho) - P (mg/1)	.005 - .049	T - .066	T - .062	T - .090

The concentrations of fecal coliform for the East Dyce and West Dyce sampling stations for the study period are presented in Table 10. Higher values occurred during the grazing season, especially with the known presence of livestock. Maximum fecal coliform levels were 450, 36, 1,600 and 397 colonies/100 mls respectively for each station. Approximately 23 percent, 23 percent, and 31 percent of the sample coliform counts exceeded the 200 colony/100 ml limit of the Montana Water Quality Criteria for the Lower East, Lower West, and Upper West Dyce stations. The Upper East Dyce station had no exceptions. Low values were associated with the spring and fall seasons.

Comments

Although the data indicated that sediment yields were higher for 1977, this condition is largely attributed to a few sample periods with high sediment concentrations. The water yield data reflect more of the general field conditions for the two sampling years. Bacteria levels were elevated at three of the stations, primarily owing to the presence of cattle near the stream course and to the low discharge in the respective streams. Because of the limited number of samples taken and the nature of the hydrochemical parameters evaluated, relationships between the water quality characteristics of Dyce Creek and the Montana Water Quality Criteria cannot be addressed.

Watson Creek Basin

The Watson Creek sample basin was visited a total of 17 and 18 times during the two hydrologic years. There were no specific accessibility or sampling problems, other than those caused by residual channel ice and low flow conditions. The Upper Watson station was monitored 17 and 17 times respectively.

Table 10. Fecal Coliform Counts (colonies/100 mls) for Dyce Creek, 1977 - 1978.

	Lower East Dyce		Upper East Dyce		Lower West Dyce		Upper West Dyce	
	1977	1978	1977	1978	1977	1978	1977	1978
April		< 5				< 5		< 5
May	< 2	89	< 2	< 1	2	59	< 2	4
June	254*	37	1(?)	< 1	86*	39	1600*	615*
July	216*	89	36(?)	5(?)	206*	97*	107*	3*
August	26*	450*	< 2(?)	3(?)	96*	223*	282*	37
September	6(?)	70*	12(?)	15(?)	82*	397*	800	13
October	4		2		13		96	
November	7		4		3		46	

* Stock visually present.

(?) Stock presence uncertain.

Channel Stability Rating

The Lower Watson Creek stream section was evaluated on September 27, 1976. The South Fork of Watson, i.e. Upper Watson above the station, was evaluated independently by Bureau personnel. The Lower Watson segment was rated as 'good' (55) (Table 11).

Precipitation

Precipitation was measured at the Upper Watson precipitation station from April 23 through November 11, 1977 and from April 6 through September 14, 1978. The general precipitation patterns during these two fiscal years are compared to those of the Dillon and Lima weather stations (Figure 55). Precipitation was generally low at this station and occurs primarily during the late spring and early summer. The two years appear comparable.

Stream Discharge

The staff-discharge rating curves for the Lower Watson and Upper Watson sampling stations are presented in Figures 56 and 57. The Lower Watson station experienced modest channel alteration during the two years. The Upper Watson station has a less well defined channel flowing through a wet meadow. Both stations sustained extremely low flows on several occasions.

The 1977 and 1978 annual hydrographs for the Lower Watson and Upper Watson Creek sampling stations are presented in Figures 58-61. Peak flow during 1977 at the Lower Watson station apparently occurred in early to mid-April during an unusually warm period. An estimated crest stage value was not available as flow was over the ice. A second peak period in mid-May included a flow of 0.80 cfs. The lowest recorded flow during 1977 was 0.10 cfs during June and July. The 1978 year produced an early peak flow of 3.2 cfs in late March, while the lowest recorded flow was 0.14 cfs

Table 11 R-1 STREAM CHANNEL STABILITY FIELD EVALUATION FORM

Lower Watson
9/27/76

Item Rated	Stability Indicators by Classes								
	EXCELLENT		GOOD		FAIR		POOR		
I. UPPER BANKS									
Landform Slope	Bank slope gradient <30%	[✓ (1)]	Bank slope gradient 30-40%	(4)	Bank slope gradient 40-60%	(6)	Bank slope gradient 60% +	(8)	8
Mass Wasting (Existing or Potential)	No evidence of past or potential for future mass wasting into channels.	(3) [✓ 2]	Infrequent and/or very small. Mostly healed over. Low future potential.	(6)	Moderate frequency & size, with some raw spots eroded by water during high flows.	(9)	Frequent or large, causing sediment nearly yearlong OR imminent danger of same.	(12)	12
Debris Jam Potential (Floatable Objects)	Essentially absent from immediate channel area.	[✓ (2)]	Present but mostly small twigs and limbs.	(4)	Present, volume and size are both increasing.	(6)	Moderate to heavy amounts, predominantly larger sizes.	(8)	8
Bank Protection from Vegetation	90% + plant density. Vigor and variety suggests a deep, dense root mass.	(3)	70-90% density. Fewer plant species or lower vigor suggests a less dense or deep root mass.	(6) [✓ 4]	50-70% density. Lower vigor and still fewer species form a somewhat shallow and discontinuous root mass.	(9)	<50% density plus fewer species & less vigor indicate poor, discontinuous, and shallow root mass.	(12)	12
II. LOWER BANKS									
Channel Capacity	Ample for present plus some increases. Peak flows contained. W/D ratio <7.	(1)	Adequate. Overbank flows rare. Width to Depth (W/D) ratio 8-15.	[✓ (2)]	Barely contains present peaks. Occasional overbank floods. W/D ratio 15-25.	(3)	Inadequate. Overbank flows common. W/D ratio >25.	(4)	4
Bank Rock Content	65% + with large, angular boulders 12" + numerous.	(2)	40 to 65%, mostly small boulders to cobble 6-12".	(4)	20 to 40%, with most in the 3-6" diameter class.	(6)	<20% rock fragments of gravel sizes, 1-3" or less.	(8)	8 ⑦
Obstructions Flow Deflectors Sediment Traps	Rocks, old logs firmly embedded. Flow pattern of pool & riffles stable without cutting or deposition.	(2)	Some present, causing erosive cross currents and minor pool filling. Obstructions and deflectors newer and less firm.	(4) [✓ 3]	Moderately frequent, moderately unstable obstructions & deflectors move with high water causing bank cutting and filling of pools.	(6)	Frequent obstructions and deflectors cause bank erosion yearlong. Sed. traps full, channel migration occuring.	(8)	8
Cutting	Little or none evident. Infrequent raw banks less than 6" high generally.	(4)	Some, intermittently at outcurves & constrictions. Raw banks may be up to 12".	(8) [✓ 6]	Significant. Cuts 12"-24" high. Root mat overhangs and sloughing evident.	(12)	Almost continuous cuts, some over 24" high. Failure of overhangs frequent.	(16)	16
Deposition	Little or no enlargement of channel or point bars.	[✓ (4)]	Some new increas in bar formation, most from coarse gravels.	(8)	Moderate deposition of new gravel & coarse sand on old and some new bars.	(12)	Extensive deposits of predominately fine particles. Accelerated bar development.	(16)	16
III. BOTTOM									
Rock Angularity	Sharp edges and corners, plane surfaces roughened.	(1)	Rounded corners & edges, surfaces smooth & flat.	[✓ (2)]	Corners & edges well rounded in two dimensions.	(3)	Well rounded in all dimensions, surfaces smooth.	(4)	4
Brightness	Surfaces dull, darkened, or stained. Gen. not "bright".	(1)	Mostly dull but may have up to 35% bright surfaces.	[✓ (2)]	Mixture, 50-50% dull and bright, ± 15%, ie 35-65%.	(3)	Predominately bright, 65% +, exposed or scoured surfaces.	(4)	4
Consolidation or Particle Packing	Assorted sizes tightly packed and/or overlapping.	(2)	Moderately packed with some overlapping.	[✓ (4)]	Mostly a loose assortment with no apparent overlap.	(6)	No packing evident. Loose assortment, easily moved.	(8)	8
Bottom Size Distribution & Percent Stable Materials	No change in sizes evident. Stable materials 80-100%.	(4)	Distribution shift slight. Stable materials 50-80%.	(8) [✓ 6]	Moderate change in sizes. Stable materials 20-50%.	(12)	Marked distribution change. Stable materials 0-20%.	(16)	16
Scouring and Deposition	Less than 5% of the bottom affected by scouring and deposition.	(6)	5-30% affected. Scour at constrictions and where grades steepen. Some deposition in pools.	(12) [✓ 9]	30-50% affected. Deposits & scour at obstructions, constrictions, and bends. Some filling of pools.	(18)	More than 50% of the bottom in a state of flux or change nearly yearlong.	(24)	24
Clinging Aquatic Vegetation (Moss & Algae)	Abundant. Growth largely moss like, dark green, perennial. In swift water too.	[✓ (1)]	Common. Algal forms in low velocity & pool areas. Moss here too and swifter waters.	(2)	Present but spotty, mostly in backwater areas. Seasonal blooms make rocks slick.	(3)	Perennial types scarce or absent. Yellow-green, short term bloom may be present.	(4)	4
COLUMN TOTALS →		10	→	38	→	-	→	7	

Add the values in each column for a total reach score here. (E. 10 + G. 38 + F. - + P. 7 = 55).

Reach score of: <38=Excellent, 39-76=Good, 77-114= Fair, 115+=Poor.

R1-2500-5 (6

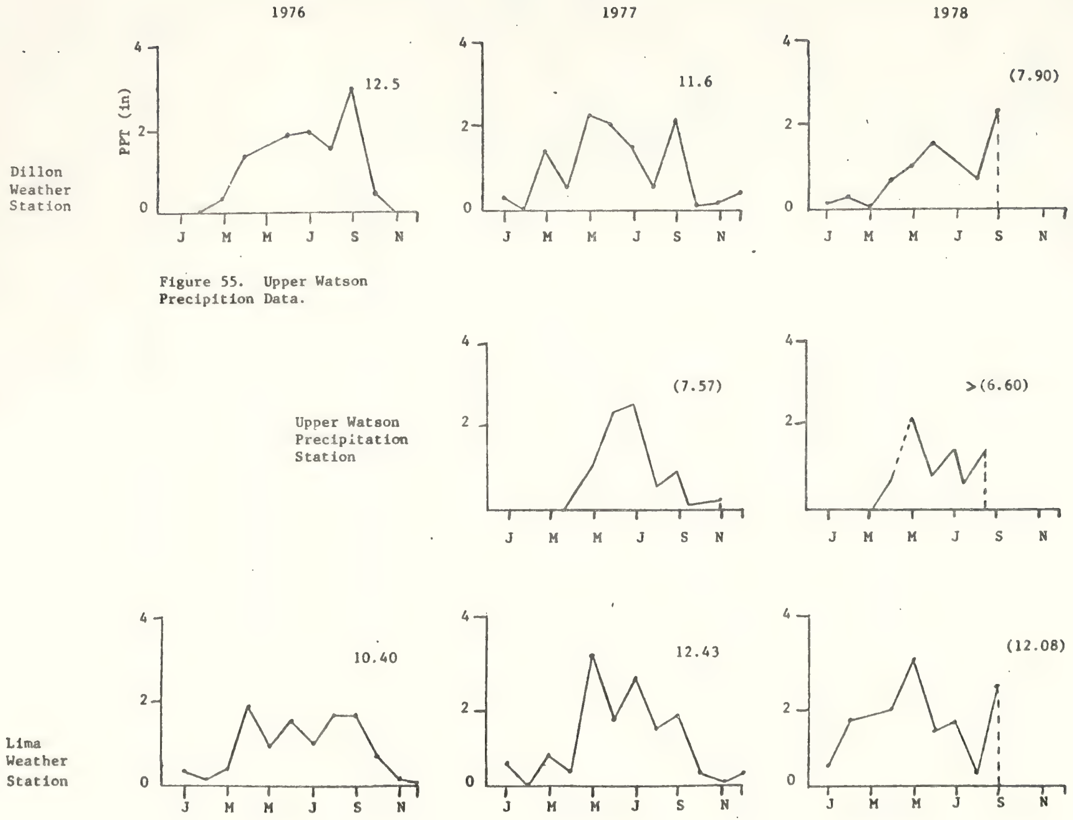


Figure 55. Upper Watson Precipition Data.

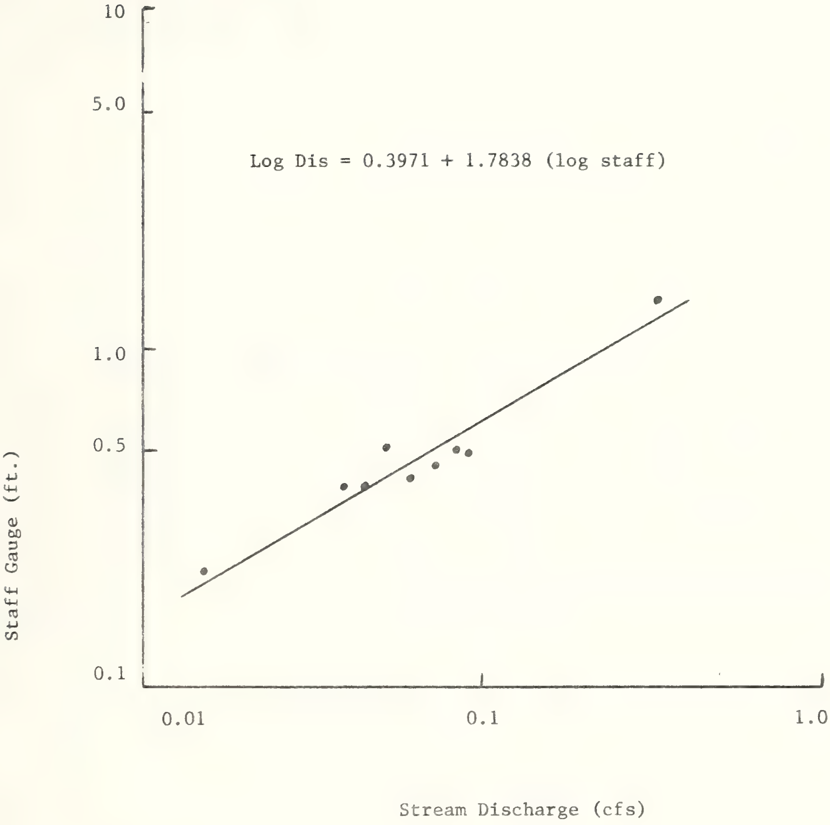


Figure 56. Staff-discharge Rating Curve for the Lower Watson Station.

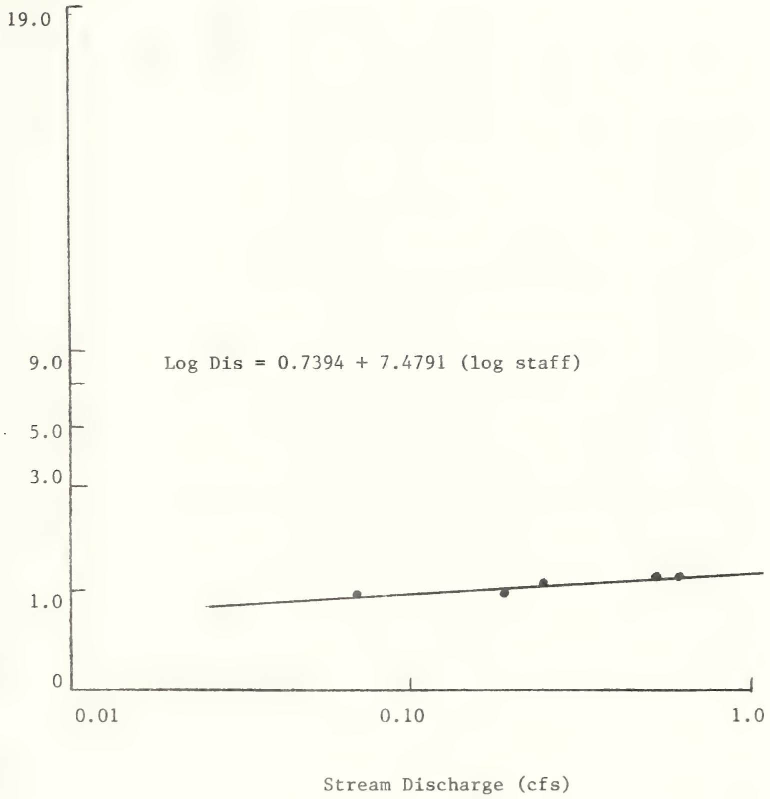


Figure 57. Staff-discharge Rating Curve for the Upper Watson Station.

*Owing to the actual negative reading, 1.0 feet must be added to each recorded value when using this rating curve.

FIGURE 58. ANNUAL HYDROGRAPH AND SEDIMENT LOADINGS

LOWER WATSON - 1977

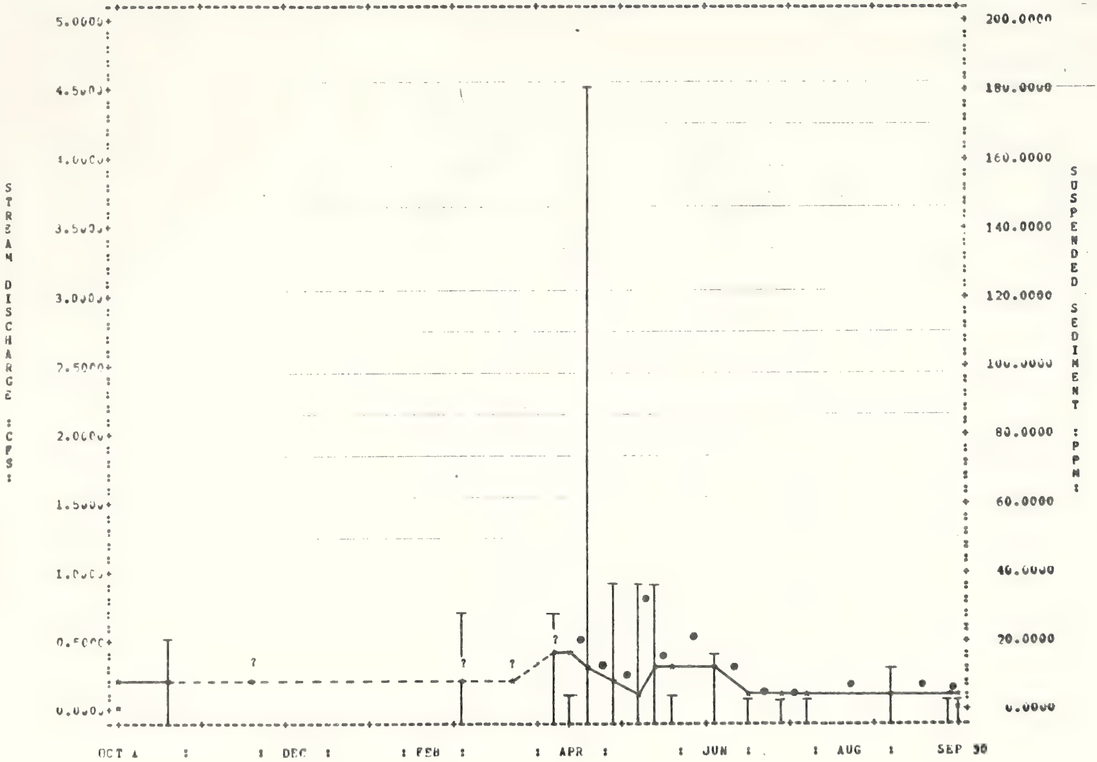


FIGURE 59. ANNUAL HYDROGRAPH AND SEDIMENT LOADINGS

LOWER WATSON - 1978

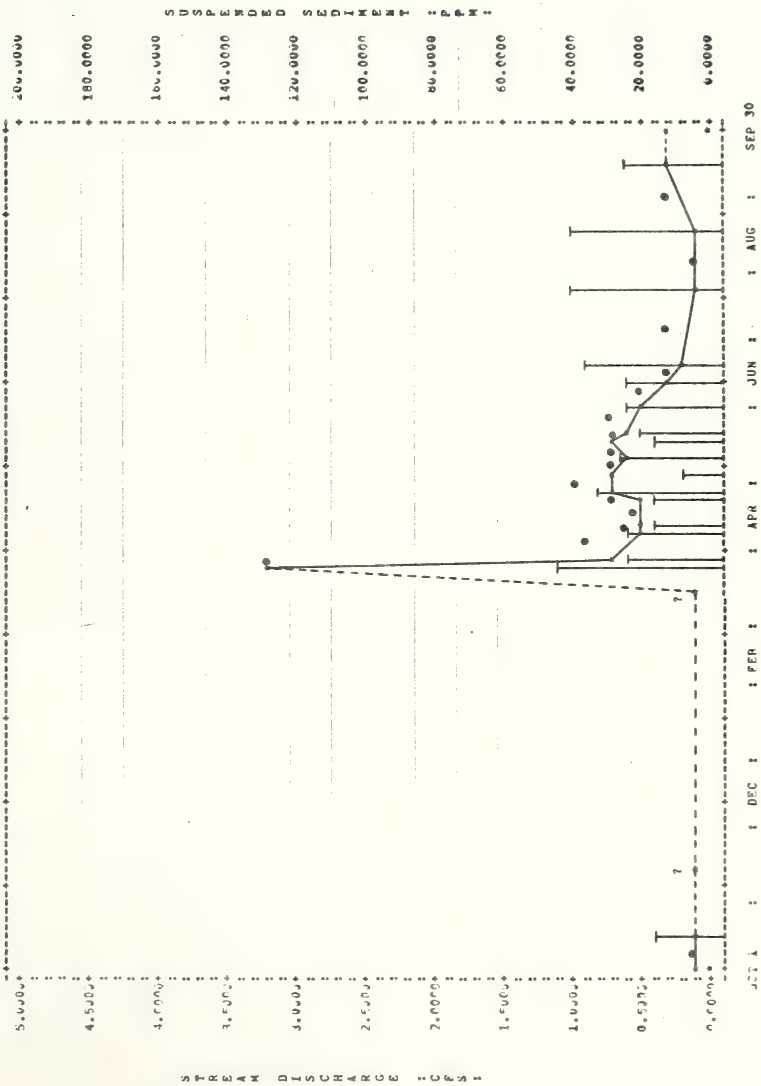


FIGURE 60. ANNUAL HYDROGRAPH AND SEDIMENT LOADINGS

UPPER WATSON - 1977

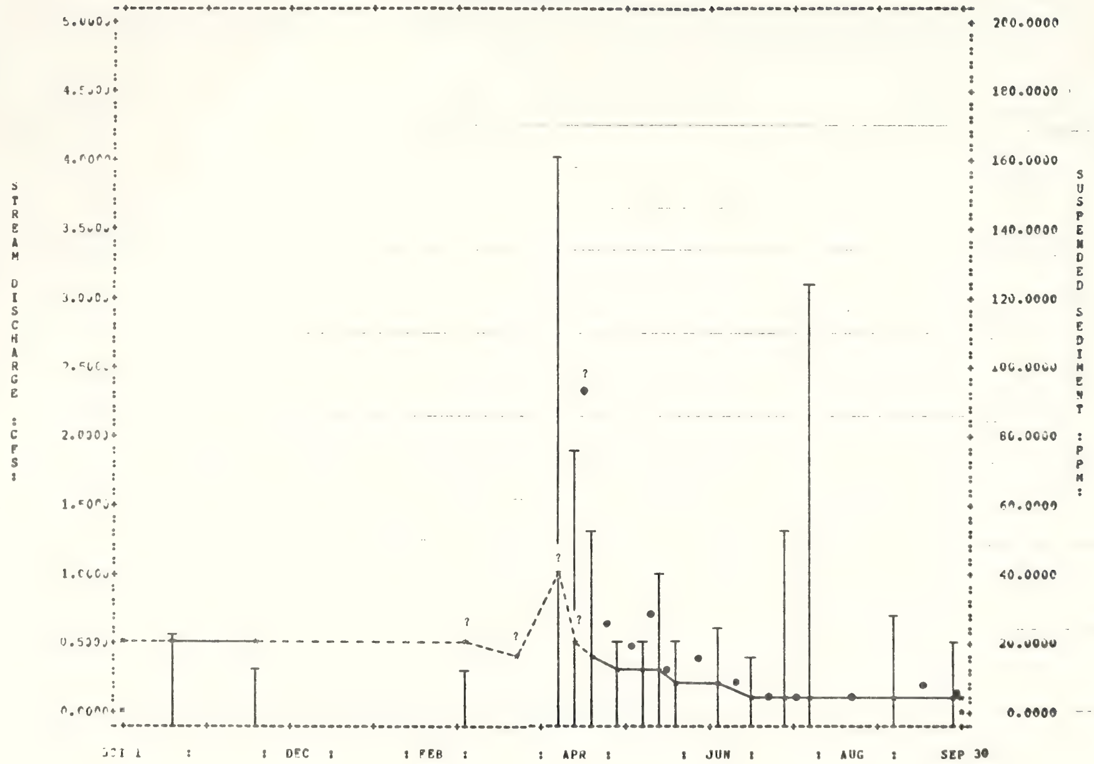
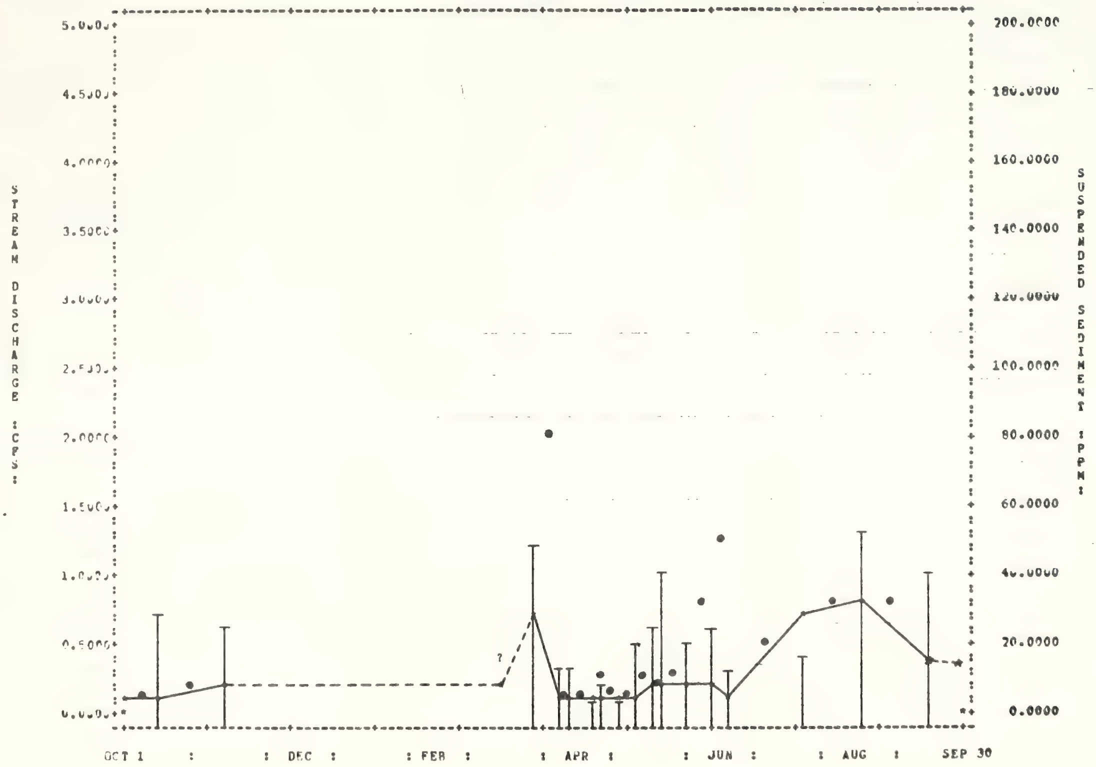


FIGURE 61. ANNUAL HYDROGRAPH AND SEDIMENT LOADINGS

UPPER WATSON - 1978



during the previous fall and in mid-August. A questionable crest discharge of 2.3 cfs was noted in mid-April, 1977 at the Upper Watson station. The lowest recorded flow for the year was 0.10 cfs in late July. In 1978, an annual peak flow of 2.0 cfs was recorded in early April, while the lowest flow was 0.11 cfs in late April. The differences noted in flow patterns for the two hydrologic years are largely attributed to differences in the annual precipitation and snow melt patterns. There is also the possibility that irrigation diversion above the Upper Watson station may have affected its flow regime.

The respective annual hydrograph data were used to estimate the annual water yields for each station (Table 12). In both years, the water yield for the Upper Watson station were comparable, 274 acre feet and 222 acre feet. This is partially attributed to the differences in estimated winter discharge values. Yields at the Lower Watson were 130 acre feet and 223 acre feet respectively, however the 1977 peak flow may not have been included in the sample.

Suspended Sediment

The annual patterns of sediment concentrations for each station by hydrologic year are depicted in Figures 58-61. Suspended sediment concentrations at the Lower Watson station ranged from <5 ppm to 180 ppm, while those for the Upper station ranged from < 5 ppm to 162 ppm. The relationships between suspended sediment and stream discharge for each station were not statistically significant (Figures 62 and 63). The variability in sediment concentration with stream flow is partially attributed to a seasonal effect, specific storm effects, presence of livestock, and to the hysteresis effect, whereby peak concentrations of suspended sediment generally occur prior to peak runoff during the rising stage (Gregory and Walling, 1973,

Table 12. Estimated Water and Sediment Yields for Watson Creek 1977 - 1978.

Station Name	Water Year	Estimated Water Yield (ac. - ft.)	Estimated Sediment Yield (tons)	Contributing Watershed (acres)	Runoff (in./ac.)	Sediment Yield (lbs/acre)
Lower Watson Station	1977	130	4.5	6,500	0.24	1.38
	1978	223	8.1	6,500	0.41	2.49
Upper Watson Station	1977	274	13 *	3,010	1.09	8.77
	1978	222	9.2	3,010	0.89	6.11

* Nearly half of this yield was attributed to one 13-day storm period of high sediment concentration.

FIGURE 62. SUSPENDED SEDIMENT VS STREAM DISCHARGE - LOWER WATSON

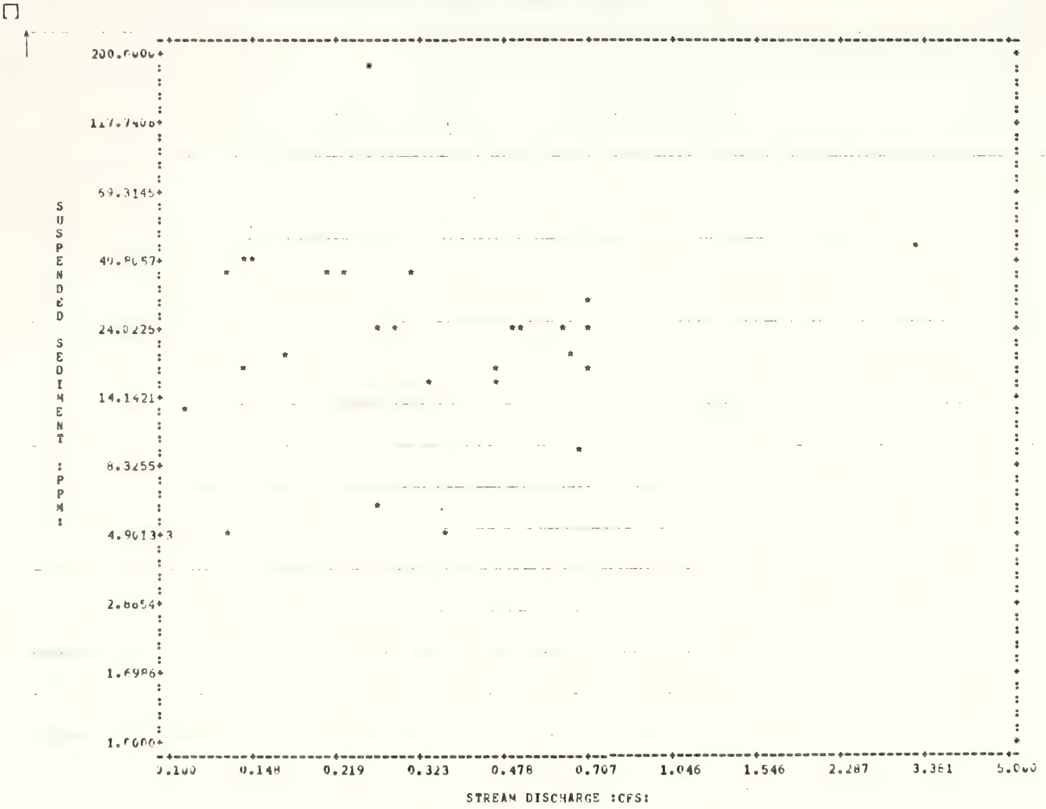
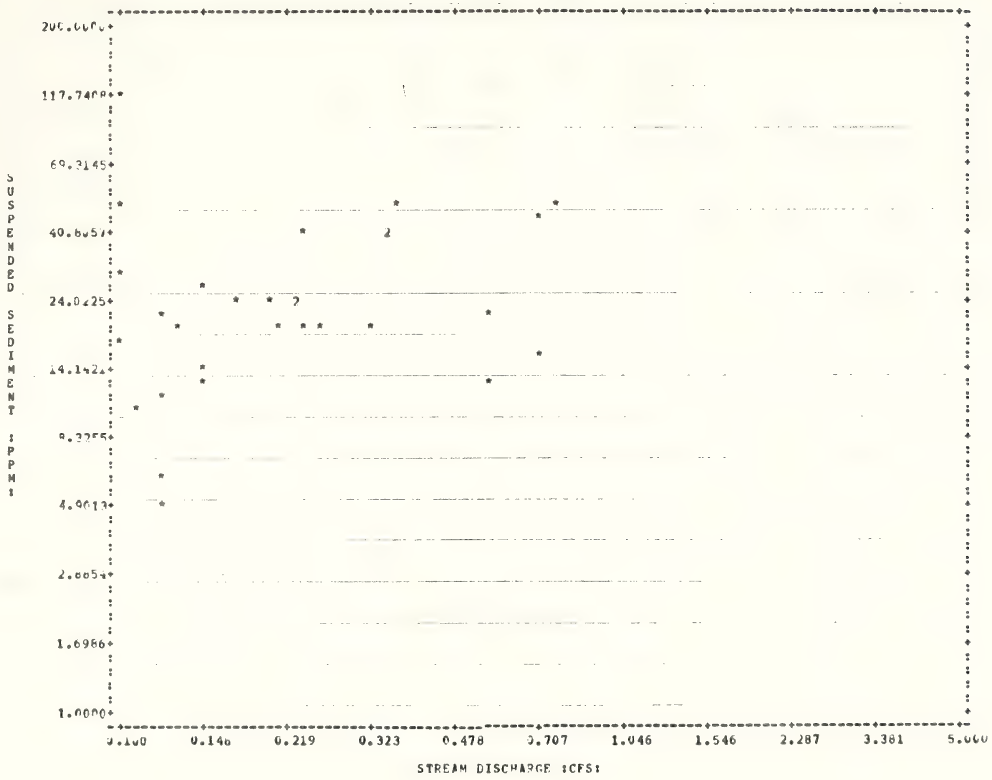


FIGURE 63. SUSPENDED SEDIMENT VS STREAM DISCHARGE - UPPER WATSON



pp. 215-219). Annual sediment yields for the two sample stations were estimated from respective water yield and sediment concentration data (Table 12). The data indicate that the Lower and Upper Watson stations produced approximately 4.5 tons and 13.2 tons of suspended sediment respectively during 1977. These yields were altered to 8.1 tons and 9.2 tons for the more active 1978 hydrologic year. The higher sediment yield for Upper Watson in 1977 is primarily related to one high sediment concentration value observed for a 13-day period encompassing April 8th.

Hydrochemical Parameters

The concentration of dissolved solids is inversely related to stream discharge so that lower concentrations occur during periods of high runoff, while higher concentrations are found during periods of low summer base flow (Gunnerson, 1967; Gregory and Walling, 1973, pp. 219-225). Patterns for specific ions, especially the ecologically important ones, often vary from this generalization (Likens, et al., 1977, pp. 74-76).

Specific conductance for the Lower Watson station ranged from a low of 188 μmhos during high spring runoff to a high of 815 μmhos during summer base flow. At the Upper Watson station, values ranged from 180 μmhos to a high of 420 μmhos. The relationships between specific conductance and stream discharge for each station were statistically significant and are presented in Figures 64 and 65. Variation in specific conductance with stream discharge is partially attributed to seasonal and storm hysteresis effects (Gregory and Walling, 1973, pp. 219-225). The ranges in ionic concentration for specific ions are presented in Table 13.

FIGURE 64. CONDUCTIVITY VS STREAM DISCHARGE - LOWER WATSON

LOG COND = 2.3798 - 0.3864(LOG DIS)

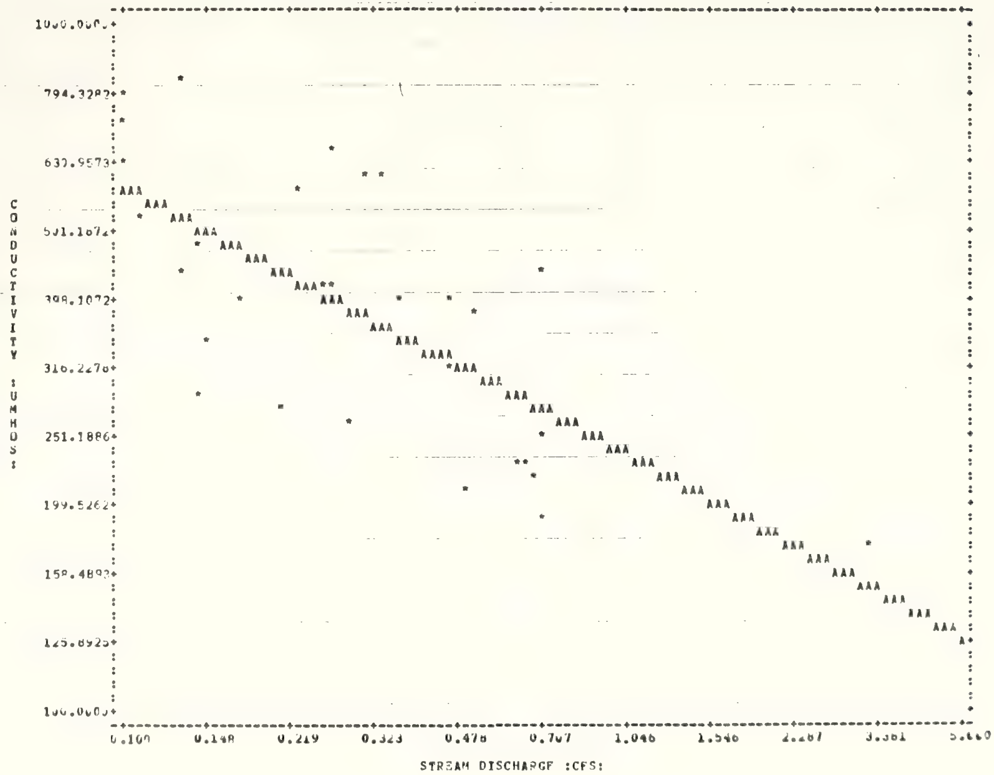


FIGURE 65. CONDUCTIVITY VS STREAM DISCHARGE - UPPER WATSON

LOG COND = 2.3748 - 0.1724(LOG DIS)

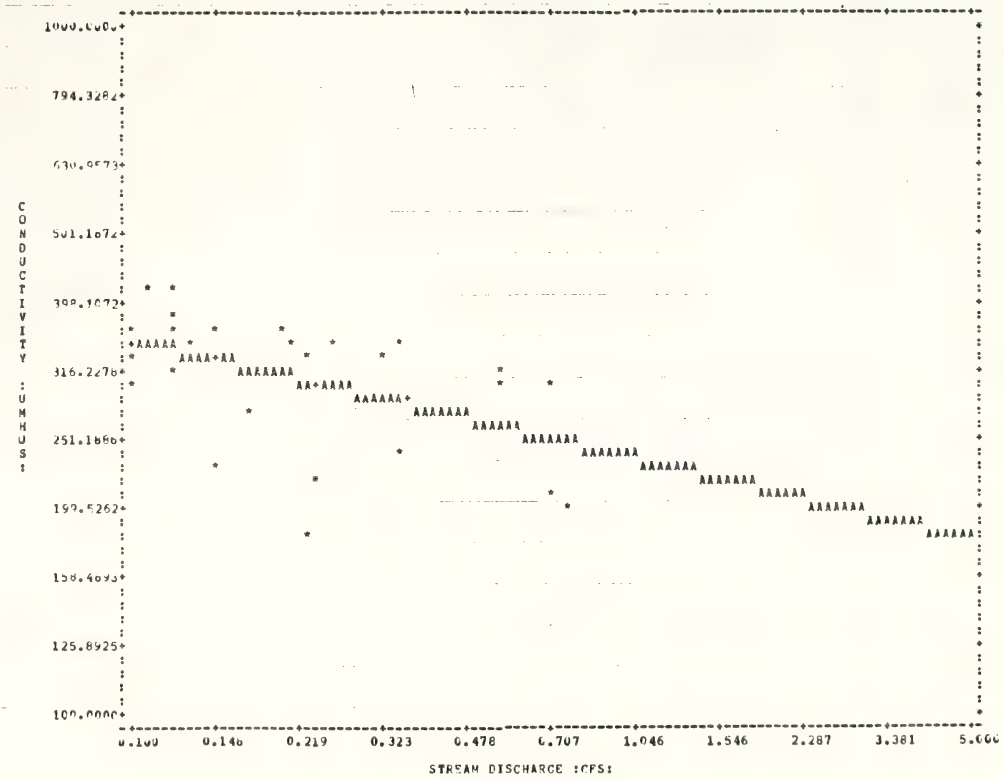


Table 13. Ranges in Hydrochemical Parameter for Watson Creek, 1977 - 1978.

	Lower Watson	Upper Watson
pH	7.05 - 8.29	7.45 - 8.11
Alkalinity ($CaCO_3$) (mg/l)	72 - 237	84 - 131
Specific Conductance (µmhos)	188 - 815	180 - 420
Total Dissolved Solids (mg/l)	122 - 530	117 - 273
Ca (mg/l)	22 - 103	22 - 44
Mg (mg/l)	5.2 - 31	6.0 - 13
Na (mg/l)	11 - 91	9.7 - 31
K (mg/l)	2.9 - 15	3.1 - 9.1
HCO_3 (mg/l)	87 - 290	101 - 160
SO_4 (mg/l)	10 - 147	9 - 52
NH_4 (mg/l)	$<$.01 - (.97)	$<$.01 - (3.2)
NO_2 + NO_3 - N (mg/l)	$<$.01 - .15	$<$.01 - .08
PO_4 (Ortho) - P (mg/l)	.082 - .310	.059 - .202

Bacteria Levels

The concentration of fecal and total coliform in streams draining rangeland watersheds is directly related to the number of cattle present, their access to the stream, the physical and hydrological characteristics of the basin, local weather conditions (Kunkle, 1970; Stephensen and Street, 1978), and the time of day (Kunkle and Meiman, 1968). Seasonal patterns include a spring "flushing" effect during the rising stage (Kunkle and Meiman, 1968), with high counts during the low flow summer period, counts which often continue for some period after the cattle have been removed from the area (Stephensen and Street, 1978). This seasonal pattern may briefly be modified by local storms which produce their own "flushing" effect, and which may or may not be followed by a short term dilution period.

The concentrations of fecal coliform for the Lower and Upper Watson stations for the study period are presented in Table 14. Higher values occurred during the grazing season, especially with the known presence of livestock. Maximum fecal coliform levels were $>$ 10,000 and 690 colonies/100 mls respectively for each station. Approximately 54 percent and 15 percent of the sample coliform counts exceeded the 200 colony/100 ml limit of the Montana Water Quality Criteria. Low values were associated with the spring season.

Comments

Watson Creek sustains a very low flow during the summer, often approaching a condition of disjunct stagnant pools in the vicinity of the Lower Watson sampling station. During spring runoff, accumulated organic and inorganic sediments are flushed and the station area suffers from erosional problems. This condition is aggravated by high livestock concentrations around the station site which also have had deleterious effects upon stream water quality and aquatic community development.

Table 14. Fecal Coliform Counts (colonies/100 mls) for Watson Creek, 1977 - 1978.

	Lower Watson		Upper Watson	
	1977 -	1978	1977 -	1978
April		< 10		< 10
May	< 2	15*	70(?)	339*
June	8(?)	10300*	690(?)	40
July	169(?)	3670(?)	116(?)	60
August	2240*	433(?)	110(?)	97
September	2280*	97	20(?)	30
October	TNTC(?)		26(?)	
November	TNTC(?)		170(?)	

* Stock visually present.

(?) Stock presence uncertain.

DISPLAY

and

BULLETIN BOARDS BULLETIN BOARDS BULLETIN BOARDS BULLETIN BOARDS BULLETIN BOARDS

IDEAS FOR TEACHERS
IDEAS
IDEAS
IDEAS

GETTING GOING CREATIVELY
CREATIVELY
CREATIVELY
CREATIVELY